T.O. 35C2-3-442-12
TM 5-6115-600-34
NAVFAC P-8-628-34
TM-07464B-35

TECHNICAL MANUAL

INTERMEDIATE (FIELD) (DIRECT AND GENERAL SUPPORT) AND DEPOT LEVEL MAINTENANCE MANUAL

GENERATOR SET, DIESEL ENGINE DRIVEN, TACTICAL SKID MTD 100 KW 3 PHASE, 4 WIRE, 120/208 AND 240/416 VOLTS.

DOD MODEL	CLASS	HERTZ	NSN
MEP0078	UTILITY	50/60	6115-01-036-6374

INCLUDING OPTIONAL KITS

DOD MODEL	NOMENCLATURE	NSN
MEP007BWF	WINTERIZATION KIT, FUEL BURNING	6115-01-131-7228
MEP007BWE	WINTERIZATION KIT, ELECTRIC	6115-01-125-9368
ME116AWM	WHEEL KIT ASSEMBLY	6115-01-135-6165

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USAF

WARNING

HIGH VOLTAGE

is produced when this generator set is in operation.

DEATH

or severe burns may result if personnel fail to observe safety precautions. Do not operate this generator set until the ground terminal stud has been connected to a suitable ground. Disconnect the battery ground cable before removing and installing components on the engine or in the electrical control panel system.

Do not attempt to service or otherwise make any adjustments, connections, or reconnections of wires or cables until generator set is shut down and completely de-energized.

WARNING

DANGEROUS GASES

Batteries generate explosive gas during charging; therefore, utilize extreme caution, do not smoke, or use open flame in vicinity when servicing batteries.

Exhaust discharge contains noxious and deadly fumes. Do not operate generator sets in enclosed areas unless exhaust discharge is properly vented to the outside.

When filling fuel tank, maintain metal to metal contact between filler nozzle and fuel tank. Do not smoke or use an open flame in the vicinity.

WARNING

LIQUIDS UNDER PRESSURE

are generated as a result of operation of the generator set. Do not expose any part of the body to a high pressure leak in the fuel system of the generator set.

Relieve pressure from radiator before removing radiator cap.

WARNING

NOISE HAZARD

Operation of this equipment presents a noise hazard to personnel in the area. The noise level exceeds the allowable limits for unprotected personnel. Wear ear muffs or ear plugs which were fitted by a trained professional.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

WARNING

Welding operations produce heat, highly toxic fumes, injurious radiation, metal slag, and airborne particles. Welding goggles, the proper tinted lenses, apron or jacket, and welder's boots are required.

WARNING

Compressed air used for cleaning or drying can create airborne particles that may enter the eyes. Pressure shall not exceed 30 psig (206 kPa). Wearing of goggles is required.

WARNING

Steam or vapor pressure cleaning creates hazardous noise levels and severe burn potential. Skin, eye, and ear protection is required.

WARNING

An acetylene torch is capable of producing heat, highly toxic fumes, injurious radiation, metal slag, and airborne particles. Although the torch is not being used for welding, welding goggles, the proper tinted lenses, apron or jacket, and welder's boots are required.

WARNING

Avoid breathing fumes generated by soldering. Eye protection is required. Remove rings and watches while soldering.

~~WARNING~~

del see
IWS

OS 1

~~Cleaning solvent trichloroethane (Tri-ethane) 1.1.1 (MIL-T-81533A) is flammable and toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory tract protection is required.~~

WARNING

Paint is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

WARNING

Use heavy duty work gloves to avoid injury to personnel.

WARNING

Stay clear of engine during lifting.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside control cubicle with generator set operating.

WARNING

Disconnect the negative cable of either battery.

del. see OS-1 WS.

~~WARNING~~

~~Ground generator armature and exciter windings securely when testing generator field windings. Ground generator field and generator armature windings securely when testing exciter windings.~~

WARNING

Locks (20) can be thrown from valve when spring compressor is released. Be sure locks are secure before releasing compressor.

WARNING

Make sure kit power cable is removed from power supply.

Intermediate (Field) (Direct and General Support)
and
Depot Level Maintenance Manual

GENERATOR SET, DIESEL ENGINE DRIVEN
NSN 6115-01-036-6374

NOTE

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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. SCOPE. This manual contains instructions for use in maintaining the 100 KW Diesel Engine Driven Generator Set, Model MEP007B. The 50/60 Hertz Utility (Mode I, Class 1) set is used in applications where precise power is not required. The maintenance procedures described herein are within the scope of intermediate and depot maintenance personnel as allocated by the Maintenance Allocation Chart (MAC). These procedures are for the generator set, its accessories, and auxiliaries. The procedures specified in this manual shall be followed if in conflict with the contents of any referenced document.

1-2. LIMITED APPLICABILITY. Some portions of this publication are not applicable to all services. These portions are prefixed to indicate the services to which they pertain: (F) for Air Force, (A) for Army, (N) for Navy, and (MC) for Marine Corps. Portions not prefixed are applicable to all services.

1-3. MAINTENANCE FORMS AND RECORDS. The forms and records used for maintenance purposes by the various services are specified as follows:

a. (F) Maintenance forms and records used by Air Force personnel are prescribed in AFM-66-1 and the applicable 00-20 Series Technical Orders.

b. (A) Maintenance forms and records used by Army personnel are prescribed by TM 38-750.

c. (N) Navy users should refer to their service peculiar directives to determine applicable maintenance forms and records to be used.

d. (MC) Maintenance forms and records used by Marine Corps personnel are prescribed by TM 4700-15/1.

1-4. REPORTING OF ERRORS. Reporting of errors, omissions, and recommendations for improvement of this publication by the individual user is encouraged.

Reports should be submitted as follows:

a. (F) Air Force - AFTO Form 22 directly to: Commander, Sacramento Air Logistics Center, ATTN: MMEDT, McClellan Air Force Base, CA 95652, in accordance with TO-00-5-1.

b. (A) Army - DA Form 2028 directly to: Commander, US Army Troop Support and Aviation Materiel Readiness Command, ATTN: DRSTS-MTT, 4300 Goodfellow Boulevard, St. Louis, MO 63120.

c. (N) Navy - by letter directly to: Commanding Officer, CB Center Parts Control Center, ATTN: Code 153, Port Huenene, CA 93043.

d. (MC) Marine Corps - by NAVMC Form 10772 directly to: Commandant, Headquarters, US Marine Corps, ATTN: Code LMA-1, WASH DC 20380.

1-5. LEVELS OF MAINTENANCE ACCOMPLISHMENT. The authorized maintenance repair functions will be accomplished as follows:

a. (F) Air Force users shall accomplish maintenance at the user level consistent with their capability in accordance with policies established in AFM-66-1.

b. (A, MC) Army and Marine Corps users shall refer to the maintenance Allocation Chart (MAC) for tasks and levels of maintenance to be performed.

c. (N) Navy users shall determine their maintenance levels in accordance with their service directives.

Section II. DESCRIPTION AND TABULATED DATA

1-6. DESCRIPTION. A general description of the generator set is contained in the Operator and Organizational Maintenance Manual. Detailed descriptions of the components of the generator set are provided in the applicable maintenance paragraphs of this manual.

1-7. TABULATED DATA. Table 1-1 contains tabulated data pertinent to intermediate and depot maintenance personnel which is not included in the Operator and Organizational Maintenance Manual. The generator set has identification and instructional plates located throughout the set. The information pertaining to these plates is contained in the Operator and Organizational Maintenance Manual. Table 1-2 contains specific torque data applicable to the intermediate and depot levels of maintenance. Refer to table 1-3 for repair and replacement standards. Figures 1-1 through 1-4 and FO-1 through FO-6 are the schematic and wiring diagrams for the various components of the generator set. Refer to the Operator and Organizational Maintenance Manual for additional schematics and wiring diagrams.

1-8. DIFFERENCES BETWEEN MODELS. This manual covers only generator set, Model MEP007B.

1-9. (A) REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR). EIR will be prepared using DA Form 2407, Maintenance Request. Instructions for preparing EIRs are provided in TM 38-750, The Army Maintenance Management System. EIRs should be mailed directly to Commander, US Army Troop Support and Aviation Materiel Readiness Command, ATTN: DRSTS-MEM, 4300 Goodfellow Boulevard, St. Louis, MO 63120. A reply will be furnished directly to you.

1-10. (MC) REPORTING EQUIPMENT DEFICIENCY REPORT (QDR). QDR will be prepared in accordance with MCO 4855.10, utilizing standard form SF 368. Beneficial suggestions should be submitted in accordance with MCO 1650.17D.

Table 1-1. Tabulated Data

1. AC ELECTRICAL CONTROL SYSTEM	
Exciter-Regulator Assembly (A11)	
DOD Drawing Number	70-4145
Bridge Rectifier and Field Flashing Assembly	
DOD Drawing Number	70-4148
Diode, Rectifer (CR1 and CR3)	
Specification	MIL-5-19500/260
Identifying Number	JAN1N1204A
Diode, Rectifier (CR2, CR4 and CR16)	
Specification	MIL-5-19500/260
Identifying Number	JAN1204RA
Reactor	
DOD Drawing Number	70-4040
Manufacturer	Consolidated Diesel Electric Co.
Model	00000-4925
Number of Turns	300
DC Resistance at 80°F (26°C)	1.25 ohms
Test Frequency	60 Hz
Rated Voltage at No Load	120 V rms
Terminal Pull Test (Maximum)	2.5 ±0.25 lbs (1.135 ±0.113 kgs) at 80°F (26°C)
Excitation Current	3 ±.15 amps, 60 Hz, 120 V rms
Storage Temperature Range	-65 to 155°F (-53 to 68°C)
Voltage Regulator Assembly (A10)	
DOD Drawing Number	70-4115
Voltage Regulator Subassembly	
DOD Drawing Number	70-4119
Transformer, Voltage Sensing (T5)	
DOD Drawing Number	70-4032
Manufacturer	Consolidated Diesel Electric Co.
Model	00000-4831
Turns Ratio: Primary (1 and 2)/ Secondary (3 and 4)	2.3:1
DC Resistance at 80°F (26°C)	
Terminals 1 and 2	164 ohms
Terminals 3 and 4	55 ohms
Test Frequency	60 Hz

Table 1-1. Tabulated Data (Continued)

Rated Voltage at No Load	
Terminals 1 and 2	95 V rms
Terminals 3 and 4	41 V rms
Rated Current	
Terminals 1 and 2	0.025 amps
Terminals 3 and 4	0.04 amps
Maximum Direct Pull	2.5 ±0.25 lbs (1.135 ±0.113 kgs) at 80°F (26°C)
Maximum Exciting Current with 95 V RMS Applied to Terminals 1 and 2	0.02 amps rms
Storage Temperature Range	-65 to 155°F (-53 to 68°C)
Resistor (R21)	
Specification	MIL-R-39008/2
Identifying Number	RCR206912JS
Diode (CR7, CR8 to CR15, and CR17)	
Specification	MIL-S-19500/286
Identifying Number	JAN1N4247
Resistor (R16)	
Specification	MIL-R-55182/6
Identifying Number	RWR70C4990FS
Capacitor (C2 and C5)	
Specification	MIL-C-39006/9
Identifying Number	M39006/09-6529
Capacitor (C1)	
Specification	MIL-C-39006/9
Identifying Number	M39006/09-6523
Capacitor (C3)	
Specification	MIL-C-39006/9
Identifying Number	M39006/09-6526
Resistor (R2)	
Specification	MIL-R-55182/5
Identifying Number	RWR70C6310FS
Resistor (R3, R5, R6, and R7)	
Specification	MIL-R-55182/5
Identifying Number	RWR65C5620FS

Table 1-1. Tabulated Data (Continued)

Transistor (Q1 and Q2)	
Specification	MIL-S-19500/290
Identifying Number	JAN2N2904
Capacitor (C4)	
Specification	MIL-C-39006/9
Identifying Number	M39006/09-6469
Diode (VR1)	
Specification	MIL-S-19500/127
Identifying Number	JAN1N751A
Resistor (R4)	
Specification	MIL-R-55182/5
Identifying Number	RWR65C6810FS
Resistor (R8)	
Specification	MIL-R-55182/5
Identifying Number	RWR65C221FS
Resistor (R9)	
Specification	MIL-R-39008/3
Identifying Number	RCR32G101J8
Resistor (R14)	
Specification	MIL-R-39008/5
Identifying Number	RCR42G471JS
Resistor (R31)	
Specification	MIL-R-19/2
Identifying Number	RA20TAS8103A
Resistor (R32)	
Specification	MIL-R-19/2
Identifying Number	RA20TAS8502A
Resistor (R33)	
Specification	MIL-R-19/2
Identifying Number	RA20TAS8751A
Heatsink Assembly	
DOD Drawing Number	70-4117

Table 1-1. Tabulated Data (Continued)

Transistor (Q4)	
DOD Drawing Number	71-4936
Manufacturer	Solitron Devices Inc.
Model	SDT1061
Type	NPN Silicon
Breakdown Voltages:	
VCB	400
VCE	325
VEB	8
Forward Current:	
Transfer Ratio	(I_C = 3.0 amps, 1/CE = 5.04)
hFE	10 min
Saturation Current (max)	(I_C = 3.0 amps, I_B = 0.6 amp)
VCE	0.5
VBE	1.5
I_{CBO}	1 ma at 130 V ce
Component Board Assembly	
DOD Drawing Number	70-4123
Resistor (R18 and R19)	
Specification	MIL-R-39008/2
Identifying Number	RCR20G102JM
Resistor (R20)	
Specification	MIL-R-39008/3
Identifying Number	RCR32G512JS
Transistor	
Specification	MIL-S-19500/99
Identifying Number	JAN2N697
Transistor (Q3)	
DOD Drawing Number	71-4936
Manufacturer	Solitron Devices Inc.
Model	SDT1061
Type	NPN Silicon
Breakdown Voltages:	
VCB	400
VCE	325
VEB	8
Forward Current:	
Transfer Ratio	(I_C = 3.0 amps, 1/CE = 5.04)
hFE	10 min
Saturation Current (max)	(I_C = 3.0 amps, I_B = 0.6 amp)
VCE	0.5
VBE	1.5
I_{CBO}	1 ma at 130 V ce

Table 1-1. Tabulated Data (Continued)

Transformer, Saturable (T1)	
DOD Drawing Number	70-4041
Manufacturer	Consolidated Diesel Electric Co.
Model	00000-4923
Turns Ratio: Primary (1 and 2)/ Secondary (3 and 4)	2:1
Winding Terminals 5, 6 and 7	5 to 7, 410 turns, tap terminals 5 to 6 at 250 turns
DC Resistance at 80°F (26°C)	
Terminals 1 and 2	0.50 ohms
Terminals 3 and 4	0.60 ohms
Terminals 5 and 7	12 ohms (max)
Test Frequency	60 Hz
Rated Voltage at No Load	
Terminals 1 and 2	75 V rms
Terminals 3 and 4	40 V rms
Rated Current	
Terminals 1 and 2	2 amps
Terminals 3 and 4	8 amps
Maximum Direct Pull to Terminals at 80°F (26°C)	2.5 ±0.25 lbs (1.135 ±0.113 kgs)
Maximum Exciting Current with 40 V RMS Applied to Terminals 1 and 2	0.4 amp rms
Storage Temperature Range	-65 to 155°F (-53 to 68°C)
Transformer Control (T4)	
DOD Drawing Number	70-4031
Turns Ratio: Primary (1 and 2)/ Secondary (3 and 4)	2:1
DC Resistance at 80°F (26°C)	
Terminals 1 and 2	3.7 ohms
Terminals 3 and 4	1.2 ohms
Test Frequency	60 Hz
Rated Voltage at No Load	
Terminals 1 and 2	120 V rms
Terminals 3 and 4	58.5 V rms
Rated Current	
Terminals 1 and 2	1 amp
Terminals 3 and 4	2 amps
Maximum Direct Pull to Terminals at 80°F (26°C)	2.5 ±0.25 lbs (1.135 ±0.113 kgs)

Table 1-1. Tabulated Data (Continued)

Maximum Exciting Current with 120 V RMS Applied to Terminals 1 and 2	0.12 amp rms
Resistor (R10A and R10B)	
Specification	MIL-R-26/3
Identifying Number	RW31V200
Type	wound-wire
Resistor (R1)	
Specification	MIL-R-26/3
Identifying Number	RW31V911
Type	wound-wire
Resistor (R17)	
Specification	MIL-R-26/3
Identifying Number	RW31V100
Type	wound-wire
Load Measuring Unit	
DOD Drawing Number	69-785
Manufacturer	Electromagnetic Industries Inc.
Model	69-500 Rev C
Type	Electrical, three-phase load sensing
Frequency Regulation	Isochronous ±1/4 of 1 percent
Weight	3 lbs (1.36 kg)
Overall Dimensions	6.00 x 3.80 x 4.38 in. (15.2 x 9.7 x 11 cm)
2. POWER GENERATION SYSTEM	
Main Rotor Assembly	
DOD Drawing Number	70-4506
Main Rotor Subassembly	
DOD Drawing Number	70-4509
Winding Resistance	0.834 ohms ±10 percent at 77°F (25°C)

Table 1-1. Tabulated Data (Continued)

Winding Data:	
No. of Coils	4
No. of Turns/Coil	160
No. of Turns/Layer	10
Exciter Rotor Assembly	
DOD Drawing Number	70-4511
Winding Resistance	0.0703 ohms ±10 percent at 77°F (25°C)
Winding Data:	
No. of Wires/Turn	6
No. of Turns/Layer	3
No. of Wires/Coil	18
Coil Grouping	18 groups of 2 coils
Coil Span	1 and 6
Rectifier Assembly	
DOD Drawing Number	70-4512
Diode Assembly (CR1, CR2 and CR6)	
DOD Drawing Number	70-4547-1
Diode	
Specification	MIL-S-19500/297
Identifying Number	JAN1N1188
Diode Assembly (CR3 and CR5)	
DOD Drawing Number	70-4547-2
Diode	
Specification	MIL-S-19500/297
Identifying Number	JAN1N1188R
Diode Assembly (CR4)	
DOD Drawing Number	70-4547-3
Diode	
Specification	MIL-S-19500/297
Identifying Number	JAN1N1188R
DC Generator Stator	
DOD Drawing Number	70-4508
Exciter Stator Assembly	
DOD Drawing Number	70-4514
Winding Resistance	1.23 ohms ±10 percent at 77°F (25°C)

Table 1-1. Tabulated Data (Continued)

Winding Data:	
No. of Poles	6
No. of Turns/Coil	85
Insulation Resistance (min)	1 megohm at 77°F (25°C), ambient
Main Stator and Frame Assembly	
DOD Drawing Number	70-4507
Main Stator Assembly	
DOD Drawing Number	70-4513
Winding Resistance	0.00974 ohms ±10 percent at 77°F (25°C)
Winding Data:	
No. of Wires/Turn	10
No. of Turns/Coil	3
No. of Wires/Coil	30
Coil Grouping	12 groups of 6 coils
Coil Span	1 and 13
3. ENGINE	
Governor	
Manufacturer	Woodward Governor Co.
Model	8561-295
Type	PSG
Speed Droop Adjustment	External
Return Spring	Internal
Normal Engine Speed	1800 rpm (60 Hz) and 1500 rpm (50 Hz)
Normal Governor Speed	3500 rpm
Minimum Governor Speed	2100 rpm
Maximum Governor Speed	4400 rpm
4. HEATER KIT, WINTERIZATION ELECTRIC	
Control Box	
DOD Drawing Number	70-4196
Transformer	
DOD Drawing Number (T1)	70-4065
Manufacturer	Consolidated Diesel Electric Co.
Model	00000-4840
Specification	MIL-E-917, Class B
Frequency	60 Hz
Voltage (No Load):	
Terminals 1 and 2	230 V
Terminals 3 and 4	35 V

Table 1-1. Tabulated Data (Continued)

Rated Voltage:	
Terminals 1 and 2	230 V
Terminals 3 and 4	33 V
Rated Current:	
Terminals 1 and 2	0.32 amp
Terminals 3 and 4	2.1 amps
Resistance:	
Terminals 1 and 2	28.0 ohms
Terminals 3 and 4	0.70 ohms
Insulation Resistance	1.0 megohm at 77°F (25°C), ambient
Storage Temperature Range	-65 to 155°F (-53 to 68°C)
Resistor (R20)	
Specification	MIL-R-39009/1
Identifying Number	RER65F2491M
Type	Fixed, wound-wire
Diode (CR23 through CR26)	
Specification	MIL-S-19500/432
Identifying Number	JAN1N5624

Table 1-2. Special Torque Data

COMPONENT	TORQUE FOOT-POUNDS (NEWTON-METERS)
STARTER MOTOR	8 (10.86)
Intermediate to Pinion Housing Screws	
FUEL INJECTION PUMP	
Screw Holding Sleeve on Control Shaft	2 ±0.16 (2.7 ±0.2)
Fuel Injection Pump Bushing	70 ±5 (95 ±7)
Fuel Injection Pump Drive Gear Bolt	110 ±5 (149.2 ±7)
Torque Spring Cover	9 ±3 (12 ±4)
Bolt in Hole for Timing Pin	
WATER PUMP	
Impeller Bolts	28 ±1 (36.6 ±1.4)
GENERATOR	
Generator Mount to Skid Base Screws	600 (814)
Shaft Coupling to Flywheel Mounting Screws	150 (203)
Generator Frame to Flywheel Housing Mounting Screws	75 (101.7)
Main Stator Assembly Setscrews	5 (6.8)
Rectifier Assembly Setscrews	20 (27)
Spacer Setscrews	20 (27)
Shaft Coupling Screws	50 (67.8)
ENGINE	
Mounting Screws	200 (271)
TURBOCHARGER	
Screw	2.9 ±0.5 (3.95 ±0.55)
Nut	2.5 (3.4), plus 120 degrees
Bolt	14.16 ±0.8 (19.15 ±1.15)
GOVERNOR	

Table 1-2. Special Torque Data (Continued)

COMPONENT	TORQUE FOOT-POUNDS (NEWTON-METERS)
CYLINDER HEAD ASSEMBLY	
Precombustion Chamber	150 ±50 (203 ±20)
Plug	10 ±2 (14 ±3)
Cylinder Head Bolts (engine right side perimeter, and all interior)	115 (155), then to 175 ±5 (236 ±6.8)
Cylinder Head Bolts (engine left side perimeter only)	22 (30), then to 32 ±5 (43 ±7)
OIL PUMP	
Drive Gear Bolt	32 ±5 (43.4 ±6.8)
CONNECTING RODS AND PISTONS	
Bearing Cap Bolts	30 ±3 (40.68 ±4), plus 90 degrees
Piston Plug	30.2 ±5.2 (41 ±7)
FLYWHEEL ASSEMBLY	
Housing Bolts	32 ±5 (43.4 ±6.8)
Flywheel Bolts	150 ±20 (203 ±27)
TIMING GEARS	
Timing Cover Bolts	17 ±3 (23 ±4)
Fuel Injection Pump Drive Gear Cover Nuts	20 ±5 (27 ±7)
Crankshaft Pulley Bolt	230 ±20 (311.9 ±27.1)
CRANKSHAFT	
Plug	17 ±3 (23 ±4)
Main Bearing Cap Bolts	30 ±3 (40.7 ±4), plus 90 degrees
CYLINDER BLOCK	
Exhaust Manifold Mounting Studs	20 ±3 (27 ±4)

Table 1-3. Repair and Replacement Standards

COMPONENT	MANUFACTURER'S DIMENSIONS AND TOLERANCES SHOWN IN INCHES (MM)		DESIRED CLEARANCE SHOWN IN INCHES (MM)		MAXIMUM ALLOWABLE WEAR AND CLEARANCE SHOWN IN INCHES (MM)
	MIN	MAX	MIN	MAX	
Starting Motor Assembly:					
Brush length	0.7500 (19.0500)				0.3750 (9.5250)
Thrust washer thickness (Commutator end of armature shaft)	0.0312 (0.7925)	0.0930 (2.3622)			0.0250 (0.6350)
Thrust washer thickness (Drive end of armature shaft)	0.0950 (2.4130)				0.0900 (2.2860)
Thrust washer thickness (Intermediate bearing)	0.0312 (1.7925)				0.0280 (0.7112)
Maximum end play of armature	0.0300 (0.7620)				0.0500 (1.2700)
Thrust washer thickness (Outer washers)	0.0650 (1.6510)				
Yoke pin diameter	0.2790 (7.0866)	0.2810 (0.7197)			0.2740 (6.9596)
Yoke bore for pin	0.2820 (7.1628)	0.2830 (7.1882)			
Fit of pin in yoke			0.0010 (0.0254)	0.0040 (0.1016)	
Fit of pin in cover			0.0010 (0.0254)	0.0050 (0.1270)	
Cover bore for pin	0.2820 (7.1628)	0.2840 (7.2136)			
Commutator end head bronze bearing ID	0.6260 (15.9004)	0.6270 (15.9258)			0.6320 (16.0528)
Armature shaft diameter at commutator end	0.6230 (15.8242)	0.6250 (15.8750)			0.6200 (15.7480)

Table 1-3. Repair and Replacement Standards (Continued)

COMPONENT	MANUFACTURER'S DIMENSIONS AND TOLERANCES SHOWN IN INCHES (MM)		DESIRED CLEARANCE SHOWN IN INCHES (MM)		MAXIMUM ALLOWABLE WEAR AND CLEARANCE SHOWN IN INCHES (MM)
	MIN	MAX	MIN	MAX	
Starting Motor Assembly (cont):					
Fit of shaft in bearing			0.0010 (0.0254)	0.0040 (0.1016)	
Commutator end head bronze bearing OD	0.7540 (19.1516)	0.7550 (19.1770)			
Fit of bearing in end head			0.0020 (0.0508)	0.0040 (0.1016)	
Intermediate housing bronze bearing ID	0.8740 (22.1996)	0.8760 (22.2504)			0.8780 (22.3012)
Armature shaft diameter (Between spline and armature)	0.8700 (22.0980)	0.8720 (22.1488)			0.8670 (22.0218)
Fit of armature shaft in bronze bearing			0.0020 (0.0508)	0.0060 (0.0152)	0.0080 (0.2032)
Runout of shaft bearing with end bearing					0.0050 (0.1270)
Intermediate housing bore	0.9990 (25.3746)	1.0000 (25.4000)			
Intermediate housing sleeve bearing OD	1.0030 (25.4762)	1.0040 (25.5016)			
Fit of bearing in housing			0.0030 (0.0762)	0.0050 (0.1270)	
Pinion housing bearing ID	0.7470 (18.9738)	0.7480 (18.9992)			0.7520 (19.1008)
Armature shaft diameter (Drive end)	0.7450 (18.9230)	0.7460 (18.9484)			0.7420 (18.8468)
Fit of shaft in bearing (Drive end)			0.0010 (0.0254)	0.0030 (0.0762)	0.0060 (0.1524)

Table 1-3. Repair and Replacement Standards (Continued)

COMPONENT	MANUFACTURER'S DIMENSIONS AND TOLERANCES SHOWN IN INCHES (MM)		DESIRED CLEARANCE SHOWN IN INCHES (MM)		MAXIMUM ALLOWABLE WEAR AND CLEARANCE SHOWN IN INCHES (MM)
	MIN	MAX	MIN	MAX	
Starting Motor Assembly (cont):					
Pinion housing bore	0.8740 (22.1996)	0.8750 (22.2250)			
Pinion housing bronze bearing OD	0.8770 (22.2758)	0.8780 (22.3012)			
Fit of bearing in housing			0.0020 (0.0508)	0.0040 (0.1016)	
Pinion housing bearing ID	0.7500 (19.0500)	0.7530 (18.6690)		0.7550 (19.1770)	
Fit of shaft in intermediate housing bearing	0.0020 (0.0508)	0.0060 (0.1524)			0.0080 (0.2032)
Commutator diameter	1.6800 (42.6720)				1.6480 (41.8592)
Commutator minimum turned diameter	1.6700 (42.4180)				1.6470 (41.8338)
Commutator diameter T.I.R. runout with shaft diameters at bearings			0.0020 (0.0508)		0.0030 (0.0762)
Fuel Injection Pump:					
Diameter of fuel injection pump camshaft rear bearing surface (journal)	2.3715 (60.2360)	2.3725 (60.2620)			
Bore in rear bearing	2.3745 (60.3120)	2.3755 (60.3370)			
Rear bearing clearance					0.0006 (0.150)

Table 1-3. Repair and Replacement Standards (Continued)

COMPONENT	MANUFACTURER'S DIMENSIONS AND TOLERANCES SHOWN IN INCHES (MM)		DESIRED CLEARANCE SHOWN IN INCHES (MM)		MAXIMUM ALLOWABLE WEAR AND CLEARANCE SHOWN IN INCHES (MM)
	MIN	MAX	MIN	MAX	
Fuel Injection Pump (cont):					
Diameter of sleeve control shaft	0.3527 (8.9580)	0.3533 (8.9720)			
Sleeve control shaft bore	0.3538 (8.9860)	0.3548 (9.0120)			
Sleeve control shaft clearance					0.003 (0.070)
Diameter of fuel injection pump camshaft front bearing surface (journal)	0.9985 (25.3620)	0.9995 (25.3880)			
Bore in front bearing	1.0000 (25.4000)	1.0010 (25.4260)			
Front bearing clearance					0.003 (0.050)
Bypass valve spring length at test force (3.5 ±0.2 lbs; 16 ±1N)	0.882 (22.400)				
Free length after test	1.73 (43.90)				
Outside diameter	0.527 (13.390)				
Diameter of wire	0.045 (1.140)				
Fuel injection pump spring length at test force (12.5 ±1.3 lb; 56 ±6N)	1.35 (34.30)				
Free length after test	1.566 (34.300)				

Table 1-3. Repair and Replacement Standards (Continued)

COMPONENT	MANUFACTURER'S DIMENSIONS AND TOLERANCES SHOWN IN INCHES (MM)		DESIRED CLEARANCE SHOWN IN INCHES (MM)		MAXIMUM ALLOWABLE WEAR AND CLEARANCE SHOWN IN INCHES (MM)
	MIN	MAX	MIN	MAX	
Fuel Injection Pump (cont):					
Outside diameter	0.728 (18.490)				
Diameter of idler gear shaft in fuel pump	0.4911 (12.4660)	0.4917 (12.4900)			
Bore in idler gear	0.4923 (12.5040)	0.4929 (12.5200)			
Thickness of gears	0.3733 (9.4810)	0.3739 (9.4970)			
Clearance between end of gears and pump body	0.0006 (0.015)	0.0022 (0.056)			
Turbocharger:					
Wheel end clearance			0.006 (0.152)	0.011 (0.279)	0.011 (0.279)
Shaft end play			0.006 (0.152)	0.011 (0.279)	0.013 (0.330)
Shaft surface (journal) diameter for bearing	0.6250 (15.8750)	0.6254 (15.8850)			0.6250 (15.8750)
Bore in housing	0.9827 (24.9610)	0.9832 (24.9730)			0.9832 (24.9730)
Bearing diameter OD	0.9780 (24.8410)	0.9785 (24.8540)			0.9780 (24.8410)
Cylinder Head Assembly Group:					
Rocker arm bearing bore	0.7258 (18.4350)	0.7268 (18.4610)			
Shaft diameter	0.724 (18.389)	0.725 (18.415)			

Table 1-3. Repair and Replacement Standards (Continued)

COMPONENT	MANUFACTURER'S DIMENSIONS AND TOLERANCES SHOWN IN INCHES (MM)		DESIRED CLEARANCE SHOWN IN INCHES (MM)		MAXIMUM ALLOWABLE WEAR AND CLEARANCE SHOWN IN INCHES (MM)
	MIN	MAX	MIN	MAX	
Cylinder Head Assembly Group (cont):					
Maximum clearance					0.008 (0.200)
Bore in block for valve lifter	1.3135 (33.3630)	1.3155 (33.4130)			
Diameter of valve lifter	1.3100 (33.2740)	1.3110 (33.3000)			
Maximum clearance					0.012 (0.030)
Spacer plate thickness	0.3915 (9.9450)	0.3935 (9.9950)			
Cylinder head thickness	3.908 (99.270)	3.968 (100.790)			3.888 (98.755)
Oil Pump:					
Bore in bearing of idler gear	1.1236 (28.5390)	1.1284 (28.6610)			
Idler gear shaft diameter	1.1250 (28.5750)	1.1260 (28.6010)			
Clearance			0.0006 (0.015)	0.0064 (0.1620)	
Diameter of pump shafts	0.8745 (22.2120)	0.8749 (22.2220)			
Bore in shaft bearings	0.8760 (22.2500)	0.8766 (22.2660)			
Clearance			0.0011 (0.0280)	0.0021 (0.0540)	
Clearance between gears and pump body			0.002 (0.050)	0.026 (0.660)	

Table 1-3. Repair and Replacement Standards (Continued)

COMPONENT	MANUFACTURER'S DIMENSIONS AND TOLERANCES SHOWN IN INCHES (MM)		DESIRED CLEARANCE SHOWN IN INCHES (MM)		MAXIMUM ALLOWABLE WEAR AND CLEARANCE SHOWN IN INCHES (MM)
	MIN	MAX	MIN	MAX	
Oil Pump (cont):					
Length of gears (19, figure 11-38)	1.9993 (50.7830)	2.0013 (50.8330)			
Length of gears (14, figure 11-38)	1.4978 (38.0450)	1.4998 (38.0950)			
Clearance between end of gears and housing			0.0032 (0.0810)	0.0068 (0.1730)	
Connecting Rods and Pistons Group:					
Bore in piston for pin	1.7003 (43.1870)	1.7009 (43.2030)			
Pin diameter	1.6996 (43.1700)	1.7000 (43.1800)			
Clearance			0.0003 (0.0080)	0.0013 (0.0330)	0.002 (0.050)
Bore in rod for bearing	3.2495 (82.5370)	3.2505 (82.5630)			
Clearance between bearing and journal			0.0030 (0.0760)	0.0066 (0.1680)	0.010 (0.250)
Piston ring clearance					0.006 (0.150)
Piston ring gap (6, 7)	0.017 (0.431)	0.032 (0.813)			
Piston ring gap (8)	0.013 (0.330)	0.028 (0.712)			
Cylinder Liners:					
Bore in liner	4.750 (120.655)	4.752 (120.705)			4.755 (120.780)

Table 1-3. Repair and Replacement Standards (Continued)

COMPONENT	MANUFACTURER'S DIMENSIONS AND TOLERANCES SHOWN IN INCHES (MM)		DESIRED CLEARANCE SHOWN IN INCHES (MM)		MAXIMUM ALLOWABLE WEAR AND CLEARANCE SHOWN IN INCHES (MM)
	MIN	MAX	MIN	MAX	
Cylinder Liners (cont):					
Thickness of liner flange	0.4040 (10.2620)	0.4056 (10.3020)			0.4037 (10.2530)
Average of four projection measurements from any one liner			0.0013 (0.0330)	0.0069 (0.1750)	
Maximum permissable clearance between all four measurements					0.002 (0.050)
Maximum permissable difference between average projection of any two adjacent liners					0.002 (0.050)
Flywheel Assembly:					
Flywheel axial eccentricity					0.006 (0.150)
Flywheel radial eccentricity					0.005 (0.130)
Housing axial eccentricity					0.012 (0.300)
Timing Gears:					
Fuel injection pump idler gear end play	0.004 (0.100)	0.016 (0.410)			0.034 (0.860)
Crankshaft end play	0.0025 (0.0640)	0.0145 (0.3680)			0.025 (0.640)
Bore in bearing for idler gear	1.3762 (34.9560)	1.380 (35.052)			
Diameter of idler gear shaft	1.3736 (34.8890)	1.3746 (34.9150)			

Table 1-3. Repair and Replacement Standards (Continued)

COMPONENT	MANUFACTURER'S DIMENSIONS AND TOLERANCES SHOWN IN INCHES (MM)		DESIRED CLEARANCE SHOWN IN INCHES (MM)		MAXIMUM ALLOWABLE WEAR AND CLEARANCE SHOWN IN INCHES (MM)
	MIN	MAX	MIN	MAX	
Timing Gears (cont):					
Clearance			0.0016 (0.0410)	0.0064 (0.1630)	0.009 (0.230)
Camshaft:					
Width of groove for thrust washer	0.188 (4.780)	0.192 (4.880)			
Thrust washer thickness	0.182 (4.620)	0.184 (4.680)			
Camshaft end play			0.004 (0.100)	0.010 (0.260)	0.250 (0.635)
Diameter of camshaft bearing surface (journal)	2.3105 (58.6860)	2.3115 (58.7120)			
Bore in camshaft bearing	2.3130 (58.7400)	2.3170 (58.8620)			
Clearance			0.0015 (0.050)	0.0065 (0.150)	0.008 (0.200)
Crankshaft:					
Connecting rod bearing surface (journal) diameter	2.9984 (76.1600)	3.000 (76.2000)			
Connecting rod bearing surface (journal) width	1.872 (47.549)	1.883 (47.829)			
Clearance			0.0030 (0.0760)	0.0066 (0.1680)	0.010 (0.250)
Main bearing surface (journal) diameter	3.4984 (88.3600)	3.500 (88.990)			
Width of rear journal	1.591 (40.411)	1.599 (40.615)			

Table 1-3. Repair and Replacement Standards (Continued)

COMPONENT	MANUFACTURER'S DIMENSIONS AND TOLERANCES SHOWN IN INCHES (MM)		DESIRED CLEARANCE SHOWN IN INCHES (MM)		MAXIMUM ALLOWABLE WEAR AND CLEARANCE SHOWN IN INCHES (MM)
	MIN	MAX	MIN	MAX	
Crankshaft (cont):					
Width of intermediate journals		1.712 (43.485)			
Clearance	0.0030 (0.0760)	0.0066 (0.1650)			0.010 (0.250)
Thrust plate thickness	0.2135 (5.4230)	0.2165 (5.4990)			
Cylinder Block:					
Bore in block for main bearings	3.8155 (96.9130)	3.8165 (96.9390)			
Bore in block for camshaft bearings	2.5620 (65.0750)	2.5640 (65.1250)			
Depth to recess camshaft bearings from end of block	0.04 (1.00)	0.08 (2.00)			
Dimension from center of main bearing bore to top of cylinder block	15.093 (383.360)	15.105 (383.660)			
Dimension from center of main bearing bore to bottom of cylinder block	6.059 (153.870)	6.067 (154.070)			
Spacer plate thickness	0.3915 (9.9450)	0.3935 (9.9950)			
Minimum permissable counterbore depth					0.007 (0.178)
Maximum permissable counterbore depth					0.030 (0.760)

Table 1-3. Repair and Replacement Standards (Continued)

COMPONENT	MANUFACTURER'S DIMENSIONS AND TOLERANCES SHOWN IN INCHES (MM)		DESIRED CLEARANCE SHOWN IN INCHES (MM)		MAXIMUM ALLOWABLE WEAR AND CLEARANCE SHOWN IN INCHES (MM)
	MIN	MAX	MIN	MAX	
Generator:					
Bearing ID	2.7551 (69.9795)	2.7559 (69.9998)			
Bearing OD	5.9047 (149.9794)	5.9055 (149.9997)			
Shaft bearing surface diameter	2.7560 (70.0024)	2.7565 (70.0151)			
Endbell bearing contact surface	5.9055 (149.9997)	5.9062 (150.0017)			
Fuel Burning Winterization Kit:					
Heater Coolant Pump:					
Rotor head diameter	0.904 (22.962)	0.906 (23.012)			
Rotor head length	0.246 (6.248)	0.248 (6.299)			
Rotor bore diameter	0.3033 (7.7038)	0.3038 (7.7165)			
Rotor blade slot width	0.0935 (23.7490)	0.0945 (24.0003)			
Rotor blade slot depth	0.263 (6.680)	0.268 (6.807)			
Blade:					
Height	0.247 (6.274)	0.249 (6.325)			
Thickness	0.091 (2.311)	0.093 (2.362)			
Width	0.247 (6.274)	0.249 (6.325)			

Table 1-3. Repair and Replacement Standards (Continued)

COMPONENT	MANUFACTURER'S DIMENSIONS AND TOLERANCES SHOWN IN INCHES (MM)		DESIRED CLEARANCE SHOWN IN INCHES (MM)		MAXIMUM ALLOWABLE WEAR AND CLEARANCE SHOWN IN INCHES (MM)
	MIN	MAX	MIN	MAX	
Adapter bore diameter	0.315 (8.001)	0.318 (8.077)			
Relief valve spring free length					1.164 (29.566)
Heater motor end play			0.010 (0.254)	0.025 (0.635)	
Heater fuel orifice assembly opening				0.012 (0.305)	
Electric Winterization Kit Coolant Pump:					
Relief valve spring free length					1.164 (29.566)
Seal spring free length					0.470 (11.938)
Shaft diameter	0.3075) (7.8105)	0.3175 (8.0645)			
Rotor head diameter	0.904 (22.962)	0.906 (23.012)			
Rotor head length	0.246 (6.248)	0.248 (6.799)			
Rotor bore diameter	0.3033 (7.7038)	0.3038 (7.7165)			
Rotor blade slot width	0.0935 (23.7490)	0.0945 (24.0003)			
Rotor blade slot depth	0.263 (6.680)	0.268 (6.807)			
Blade:					
Height	0.247 (6.274)	0.249 (6.325)			

Table 1-3. Repair and Replacement Standards (Continued)

COMPONENT	MANUFACTURER'S DIMENSIONS AND TOLERANCES SHOWN IN INCHES (MM)		DESIRED CLEARANCE SHOWN IN INCHES (MM)		MAXIMUM ALLOWABLE WEAR AND CLEARANCE SHOWN IN INCHES (MM)
	MIN	MAX	MIN	MAX	
Electric Winterization Kit Coolant Pump (cont):					
Blade (cont):					
Thickness	0.091 (2.311	0.093 (2.362)			
Width	0.247 (6.274)	0.249 (6.325)			
Adapter bore diameter	0.315 (8.001)	0.318 (8.077)			
Cam ring bore diameter	1.000 (25.400)	1.002 (25.451)			
Cam ring width	0.249 (6.325)	0.255 (6.477)			
Motor end play			0.010 (0.254)	0.025 (0.635)	

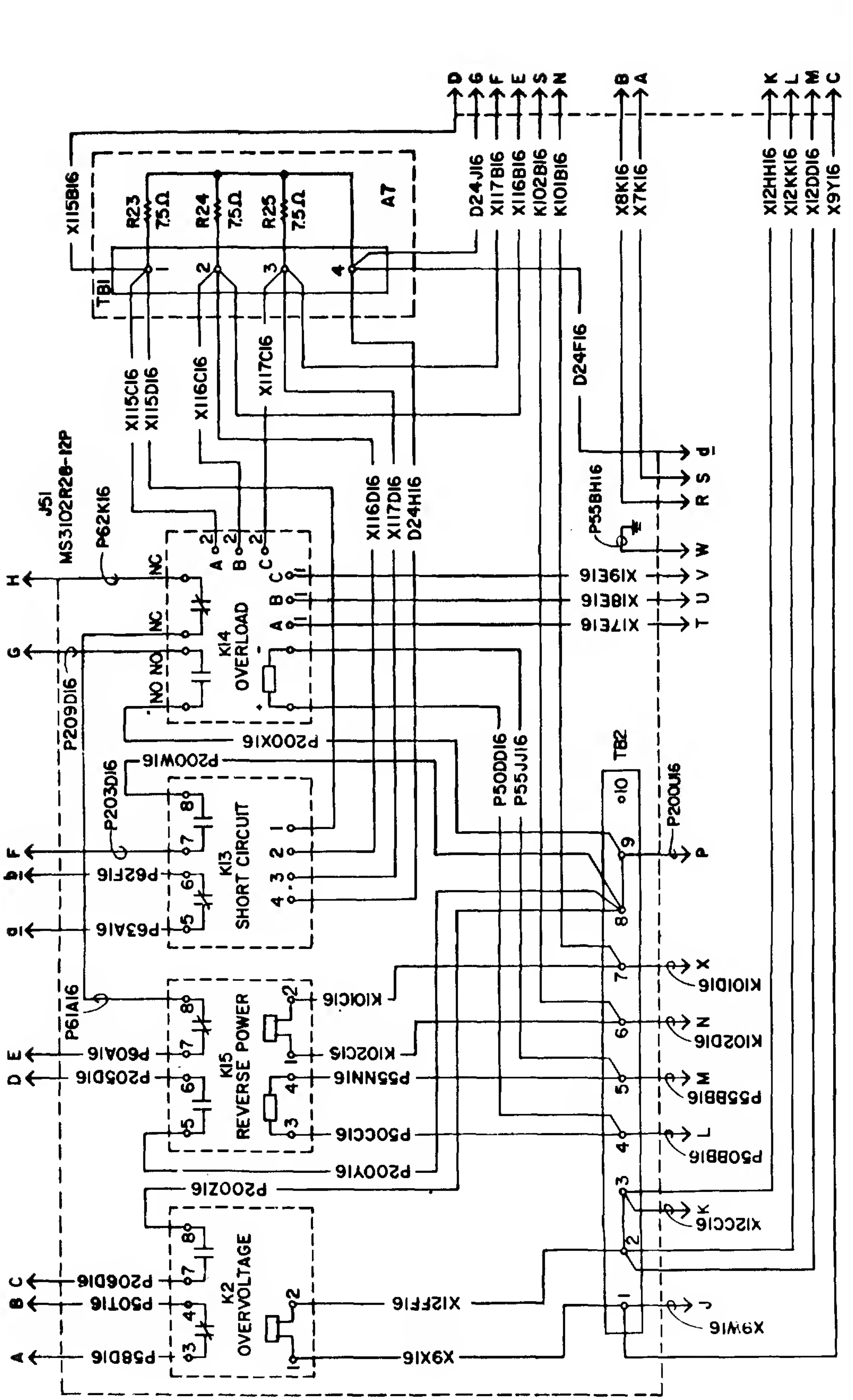


Figure 1-1. Tactical Relay Box A29, Schematic Diagram

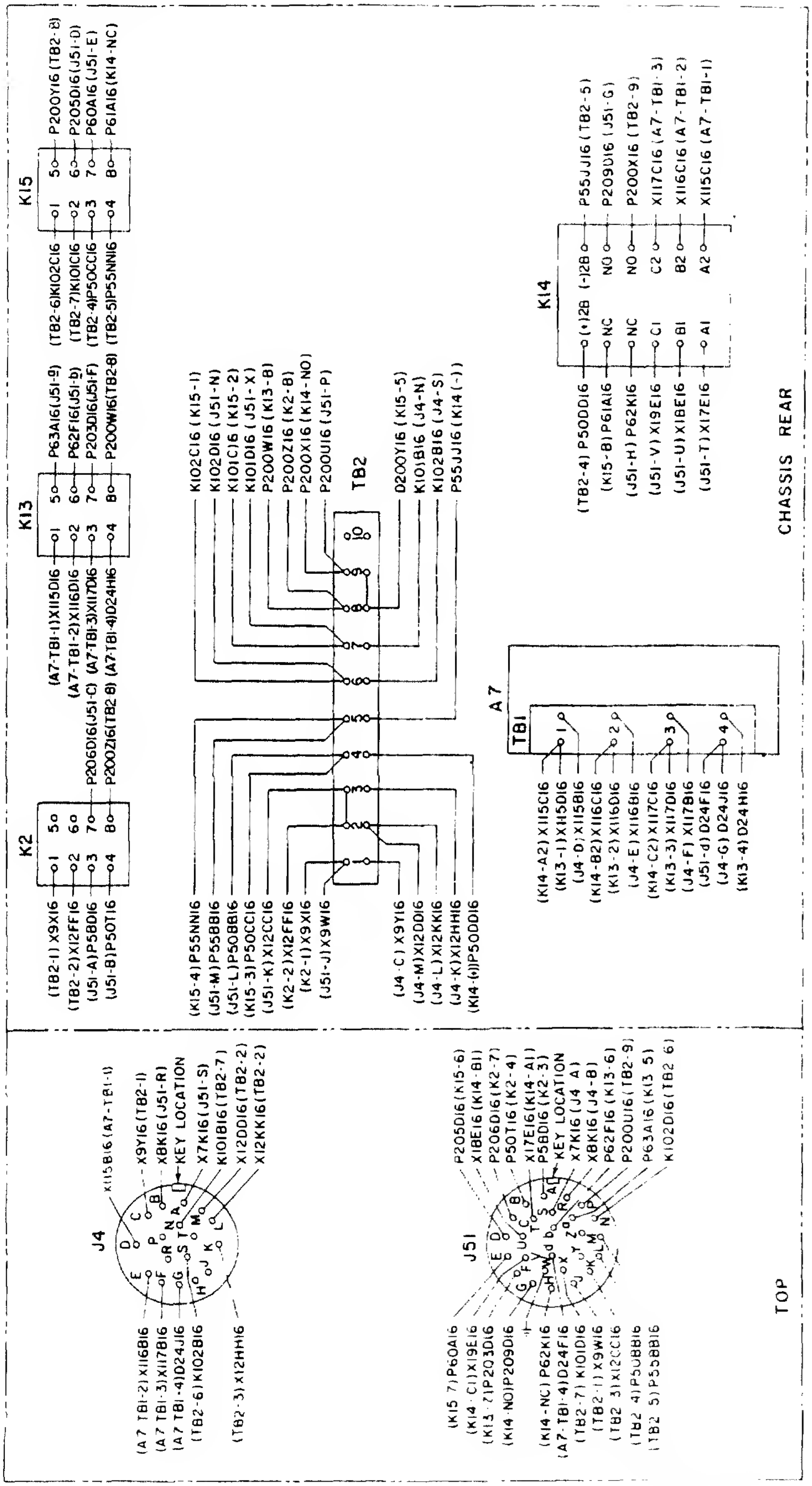
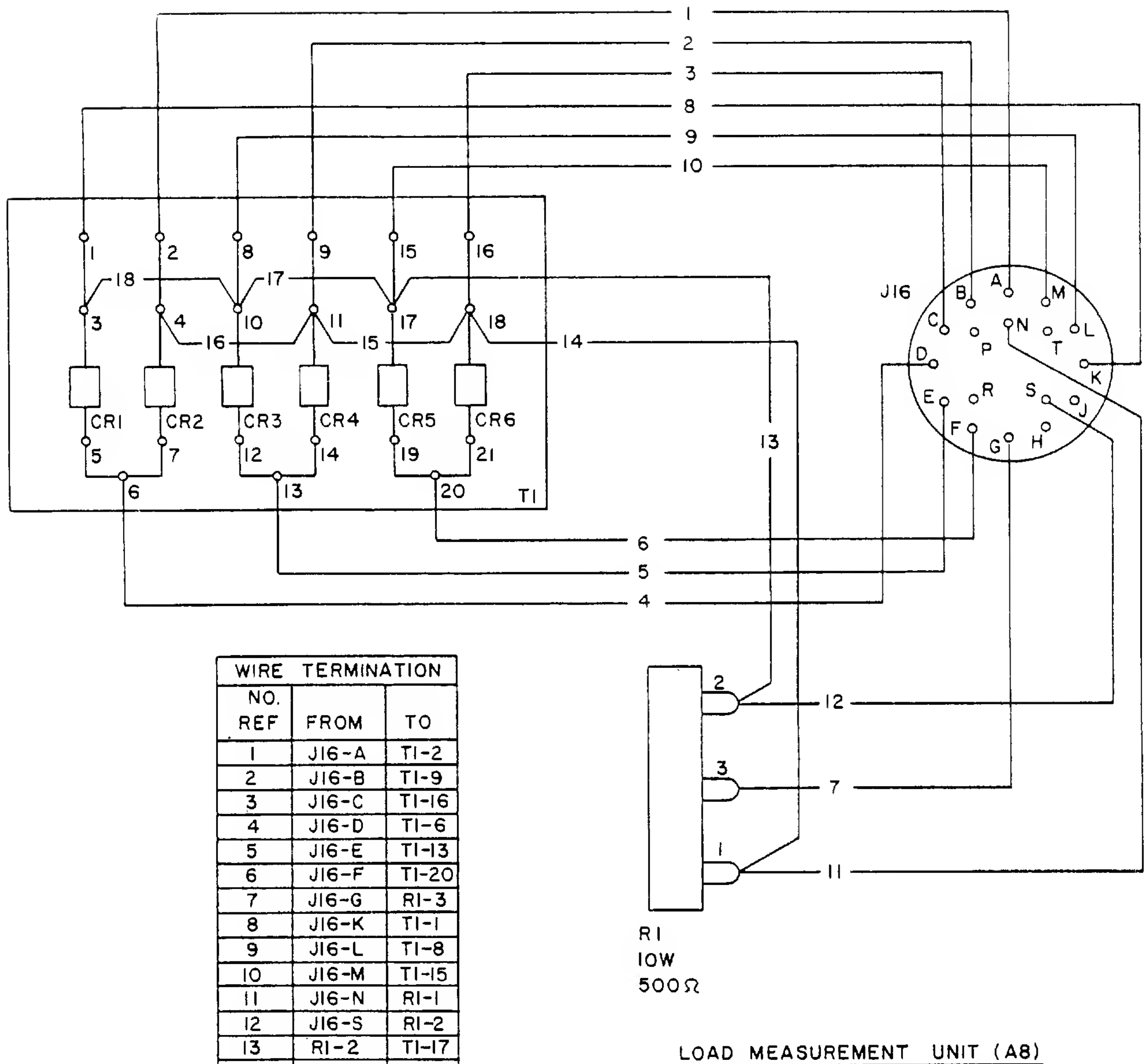


Figure 1-2. Tactical Relay Box A29, Wiring Diagram



WIRE	TERMINATION	
NO. REF	FROM	TO
1	J16-A	T1-2
2	J16-B	T1-9
3	J16-C	T1-16
4	J16-D	T1-6
5	J16-E	T1-13
6	J16-F	T1-20
7	J16-G	R1-3
8	J16-K	T1-1
9	J16-L	T1-8
10	J16-M	T1-15
11	J16-N	R1-1
12	J16-S	R1-2
13	R1-2	T1-17
14	R1-1	T1-18
15	T1-11	T1-18
16	T1-4	T1-11
17	T1-10	T1-17
18	T1-3	T1-10

Figure 1-3. Load Measuring Unit A8, Wiring Diagram

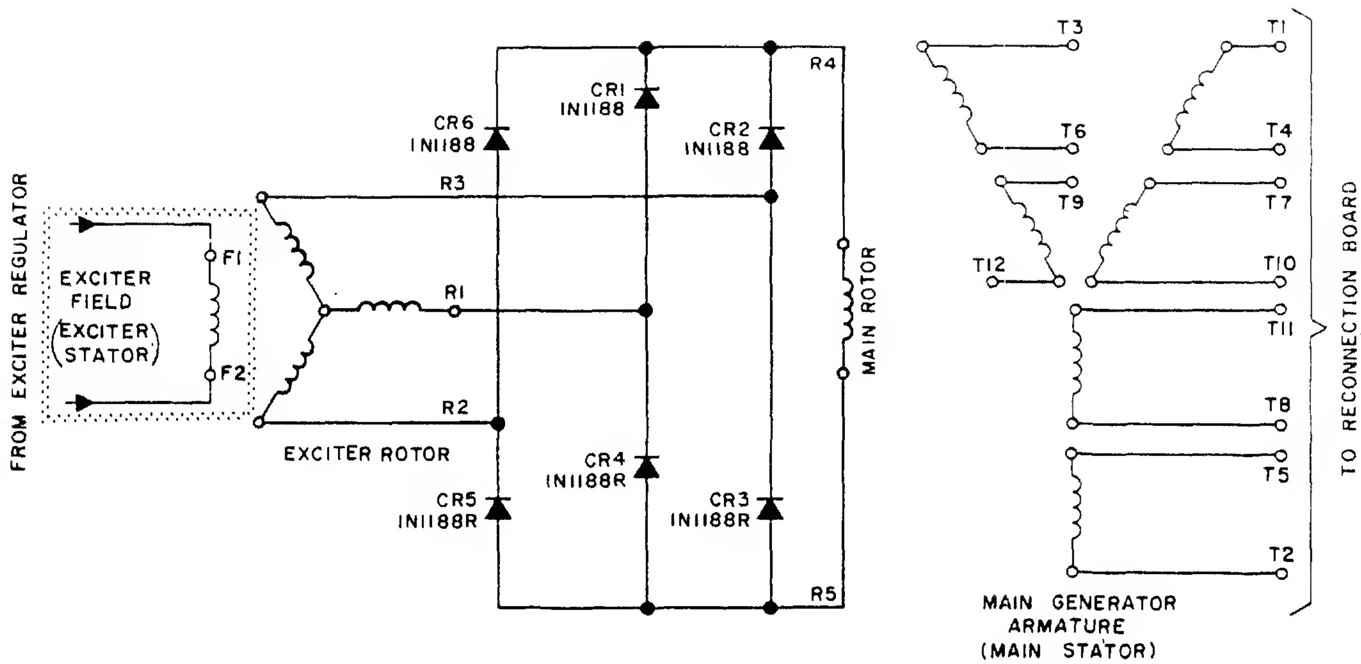


Figure 1-4. Generator Assembly, Simplified Schematic Diagram

CHAPTER 2

GENERAL MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS; SPECIAL TOOLS; TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT (TMDE), AND SUPPORT EQUIPMENT

2-1. REPAIR PARTS. Repair parts and equipment are listed and illustrated in the repair parts and special tools list manual covering organizational, intermediate, and depot maintenance for this generator set.

2-2. TOOLS AND EQUIPMENT.

a. <u>Special Tools</u>. Special tools, test, and support equipment are listed in table 2-1. Special tools are illustrated in the repair parts and special tools list manual covering organizational, intermediate, and depot maintenance for this generator set.

b. <u>Inspection and Test Equipment</u>. Common inspection, and test equipment used to determine conformance to specifications and requirements contained in this manual are listed in table 2-2.

c. <u>Fabricated Tools and Equipment</u> The specially designed (fabricated) tools and equipment required for intermediate and depot maintenance are listed and illustrated in table 2-3. These tools and equipment are not available for issue, but must be fabricated by qualified maintenance personnel.

Table 2-1. Special Tools, Test, and Support Equipment

ITEM	NSN OR REFERENCE NO.	REFERENCE FIG. NO.	REFERENCE PARA NO.	USE
Field Service Tool Group	(11083) 5P4203 (Consists of: Pin 5P229, Adapter 5P6602, Wrench 5P4205, Wrench 8S2243, Bolt 1D4533 - 1/4 NC x 2-1/2, Bolt 1D4538 - 5/16 NC x 2-1/4, Screw 8S7271, Magnetic Point 3P1569 and 5P4809, Gage 5P4209 Bolt 2H3740 - 3/4 NF x 1-1/4 Collet 3P1565, Dial Indicator 3P1567	7-9	7-15	Testing fuel injection pump calibration; adjusting fuel injection pump calibration.
Clamp	(11083) 6V190	7-9 7-10	7-15 7-16	Testing fuel injection pump calibration; adjusting fuel injection pump calibration.
Tool Group	(11083) 3P2200 (Consists of: Calibration Pump 3P1540, Bushing 4N218, Microgage 1P7379, Dial Indicator 3P1568 with Collet Base 3P2226, Calibration Pin 3P1545, Wrench 1S9836, Box 5P6510, Spring 5P6557	7-9 7-10	7-15 7-16	Testing fuel injection pump calibration; adjusting fuel calibration.

Table 2-1. Special Tools, Test, and Support Equipment (Continued)

ITEM	NSN OR REFERENCE NO.	REFERENCE FIG. NO.	PARA NO.	USE
Solid Ballhead Assembly Tool	(31361) T94312	11-23	11-6	Center governor pilot valve plunger.
Ballhead Spacer	(31361) T94063	11-23	11-6	Center governor pilot valve plunger.
Bending Tool	(31361) T82192	11-27	11-6	Bending governor spring pin for floating lever.
Pilot Valve Plunger Wrench	(31361) 370109	11-6, 11-23	11-6	Centering governor pilot valve plunger.
Seal Installation Tool	(31361) T94157	11-29	11-6	Place governor on terminal shaft.
Idler Stud Installation Tool	(31361) T79623	-	11-6	Seat governor idler stud.
Clock Valve Assembly Tool	(31361) T79516	11-10	11-6	Install governor check valves in case.
Check Valve Assembly Tool	(31361) T79679	11-10	11-6	Install governor check valves in base.
Seating Tool	(31361) T79733	11-16	11-6	Seat governor retaining ring.
Locator	(11083) 9S8871		11-37	Install crankshaft sleeve.
Distorter	(11083) 5P7312		11-39	Remove crankshaft sleeve
Installer	(11083) 5P7299 (includes bolt 7F8022)	11-51	11-44	Install crankshaft seal

Table 2-1. Special Tools, Test, and Support Equipment (Continued)

ITEM	NSN OR REFERENCE NO.	REFERENCE FIG. NO.	REFERENCE PARA NO.	USE
Bolt	S1603		7-12	Assemble fuel pump
Washer	48280		7-12	Assemble fuel pump
Washer	4N3371		7-12	Assemble fuel pump
Liner Projection Tool Group	(11083) 1P5510 (Consists of: Dial Indicator 1P2403, Contact Point, 0.88 in (22.4 mm) 1P5512, Gage Body 1P2402, Gage 1P5507	11-42	11-31	Measuring cylinder liner projection.
Adapter Plate	(11083) 1P2394	11-42	11-31	Measuring cylinder liner projection.
Push-Puller (cross bar only)	(11083) 8B7548	11-42	11-31	Measuring cylinder liner projection.
Plates (2)	(11083) 3H465	11-42	11-31	Measuring cylinder liner projection.
Bolt, 5/8-11NC-1.75 in. (44.5 mm)	(11083) S1589	11-42	11-31	Measuring cylinder liner projection.
Washer, copper	(11083) 1S379	11-42	11-31	Measuring cylinder projection.
Bolt, 5/8-11NC-6.00 in (152.4 mm)	(11083) 1D4595	11-42	11-31	Measuring cylinder liner projection.
Washer	(11083) 2S736	11-42	11-31	Measuring cylinder liner projection.
Camshaft Bearing Installation and Removal Kit	(11083) 8S2241		11-48 11-49	Removing and installing camshaft bearing

Table 2-2. Inspection and Test Equipment

ITEM	NSN OR PART NUMBER	REFERENCE PARA	REFERENCE FIG.	USE
Depth micrometer		4-12	-	To set magnetic pickup alignment.
Inside micrometer		As applicable		To measure inside diameter of engine and other components.
Outside micrometer		As applicable		To measure outside diameter of engine components.
Wheatstone bridge		As applicable		To precisely measure resistance of electrical components.
Kelvin bridge		As applicable		To precisely measure resistance of electrical components.
Multimeter (3 required)	6625-00-581-2466, or equivalent	As applicable		To measure voltage (ac and dc), current (dc), and resistance.
Pressure gage (0-20 psi)		8-4		To check coolant system pressures.
Radiator cap tester		8-5		To check radiator cap.
Vacuum tube voltmeter (or digital voltmeter)		As applicable		To check various electrical parameters.
AC power source, 120/208 V ac, 3 phase, 4 wire, 60 Hz		As applicable		To provide the ac voltage necessary to test certain electrical and electro-mechanical components.
AC ammeter (0-50 amps capability) (3 required)		As applicable		To measure ac current necessary to test certain electrical and electro-mechanical components.

Table 2-2. Inspection and Test Equipment (Continued)

ITEM	NSN OR PART NUMBER	REFERENCE PARA	REFERENCE FIG.	USE
Autotransformer 75 V amps rating (3 required)		As applicable		To provide a variable ac voltage necessary to test certain electrical and electro-mechanical components.
Variable dc power supply (15 amp capability)		As applicable		To provide the dc voltage necessary to test certain electrical and electro-mechanical components.
Frequency meter		As applicable	-	To measure the frequency of voltages used to check various electrical and electro-mechanical components.
Resistor 1.50 ohm (160 W)		6-17	6-7	To test exciter A11.
Audio oscillator (10 V p-p)		6-40	6-20	To test reverse power relay K15.
Resistor 35 ohm ±1 percent 50 watt (3 required)		6-42	6-22	To test overload relay K2
Megger (500 V)		As applicable	-	To check insulation resistance of various electrical equipments.
Resistor 7.5 ohm (10W) (3 required)		6-58	6-28	To test LMU A8.
Resistor 0.25 ohm (500 W)		4-9	4-5	Used in alternator and starter motor test.
Variable speed drive (2000 to 3000 rpm)		4-9	-	To check alternator speed.
Carbon pile (0 to 600 amp capacity)		4-22	4-9	Used in alternator and starter motor test.
Thickness gage	5210-00-221-1999, or equivalent	11-9	-	To adjust valve lash.

Table 2-2. Inspection and Test Equipment (Continued)

ITEM	NSN OR PART NUMBER	REFERENCE PARA	REFERENCE FIG.	USE
Valve spring test		11-9	-	To test intake and exhaust valve springs.
Valve seat grinding kit	4910-00-473-6437, or equivalent	11-9	-	To reface intake and exhaust valve seats.
Depth micrometer		11-9	-	Used to measure cylinder liner height projection.
Armature test set	6625-00-238-1459, or equivalent	4-22	-	To test starter motor armature for ground.
Spring scale (0 to 100 pound scale)		4-19	-	To check starter motor brush spring for proper tension.
Growler		4-19	-	To check starter motor armature for shorts.
Mica undercutter	4940-00-204-0319, or equivalent	4-20	-	To undercut mica and and starter motor commutator.
Spring scale (0 to 100 pound scale)		4-22	4-10	Used in starter motor stall torque test.
Torque arm (pony brake) (12 inches long)		4-22	4-9	Used in starter motor stall torque test.
Hand held tachometer (0 to 10,000 rpm)		4-22	4-9	Used in starter motor stall torque test.
Plastic measuring strip	Military Specification L-P-525A	2-14 11-53	- -	Used to check crankshaft clearances.
Wrench	5120-00-157-0718 P/N 5F8353	11-6		Used to remove / replace precombustion chamber.

Table 2-3. Fabricated Tools and Equipment

Nomenclature	Reference No. or NSN	Material Required
Fixture: Turbocharger Overhaul		0.50 inch (12.75 mm) steel plate 0.50 inch (12.75 mm) steel rod

Fabricated Instructions: See diagram.

Diagram:

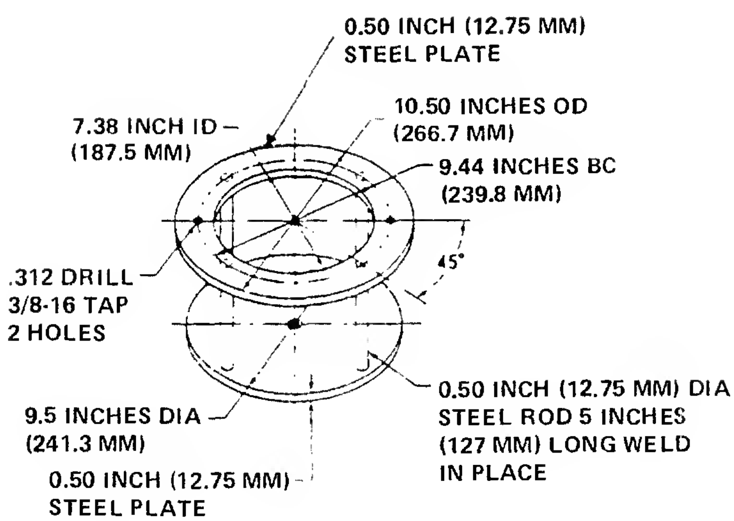


Table 2-3. Fabricated Tools and Equipment (Continued)

Nomenclature	Reference No. or NSN	Material Required
Fixture Adapter: Turbocharger Overhaul		0.50 inch (12.75 mm) steel plate

Fabrication Instructions: See diagram.

Diagram:

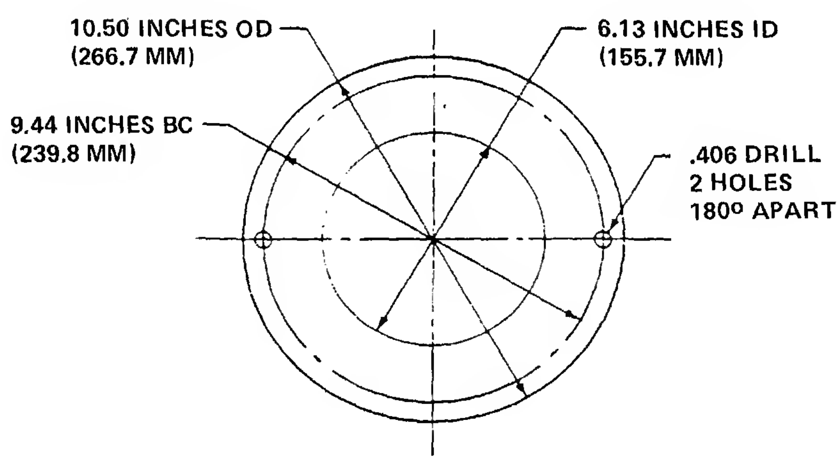


Table 2-3. Fabricated Tools and Equipment (Continued)

Nomenclature	Reference No. or NSN	Material Required
Supporting Screw: Turbocharger Overhaul		0.625 (15.9 mm) steel rod Standard Knob, 1/2-13 internal thread

Fabrication Instructions: See diagram.

Diagram:

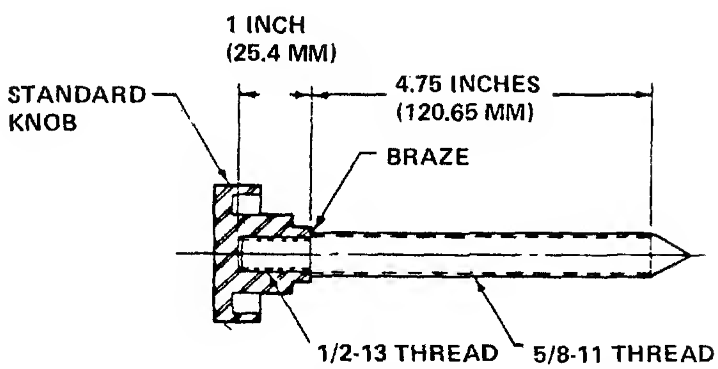


Table 2-3. Fabricated Tools and Equipment (Continued)

Nomenclature	Reference No. or NSN	Material Required
Wrench: Turbocharger Overhaul		0.50 inch (12.75 mm) steel rod 7/16 x 1.0 (25.4 mm) hex

Fabrication Instructions: See diagram.

Diagram:

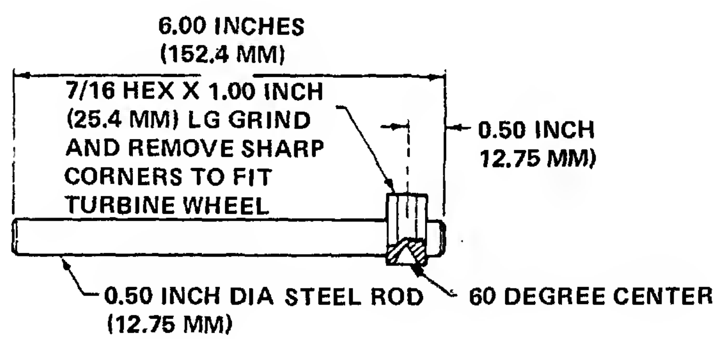


Table 2-3. Fabricated Tools and Equipment (Continued)

Nomenclature	Reference No. or NSN	Material Required
Wood Dowel: Turbocharger Overhaul		0.62 inch (15.74 mm) wood dowel

Fabrication Instructions: See diagram.

Diagram:

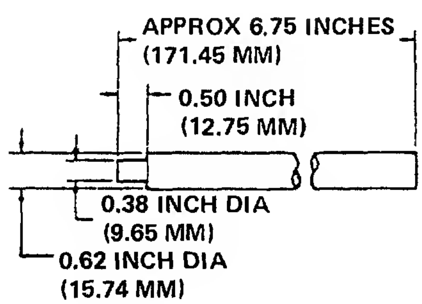


Table 2-3. Fabricated Tools and Equipment (Continued)

Nomenclature	Reference No. or NSN	Material Required
Block, Generator Shipping (used to secure rotor in generator, when generator is shipped separate from engine)		28.375 in. x 4 in. x 2.00 in. (720.725 mm x 101.6 mm x 50.8 mm) wood block

Fabrication Instructions: See diagram.

Diagram:

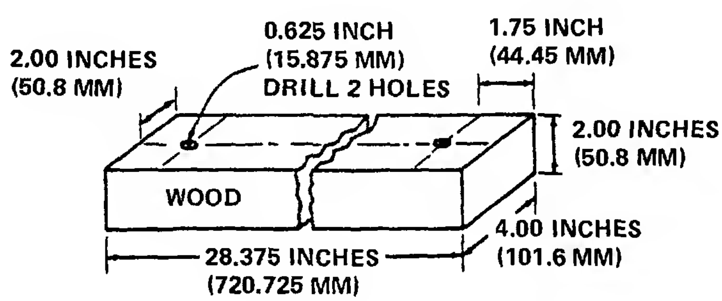
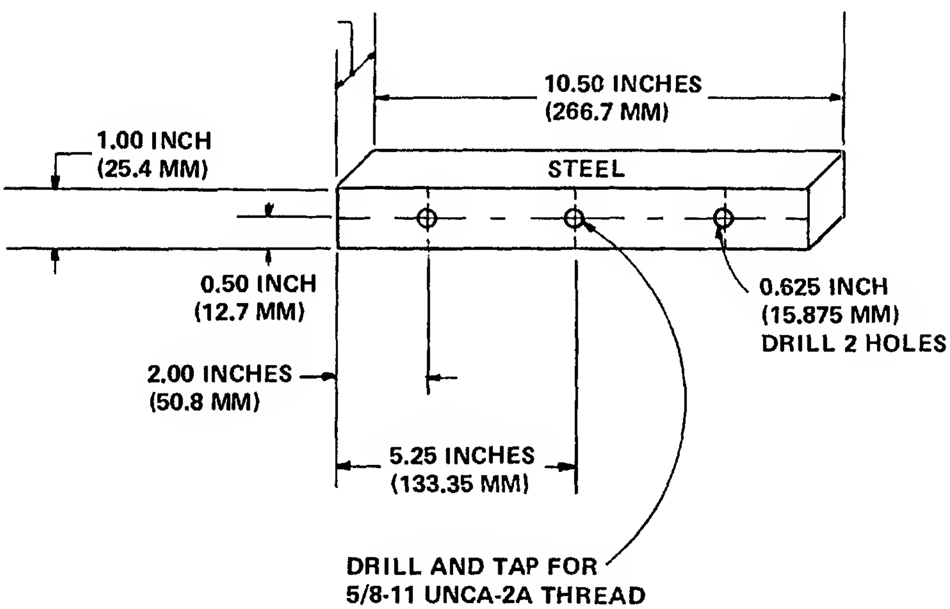


Table 2-3. Fabricated Tools and Equipment (Continued)

Nomenclature	Reference No. or NSN	Material Required
Lifting Fixture Generator Rotor		10.50 in. x 1.00 in. x 1.00 in. (266.7 mm x 25.4 mm x 25.4 mm) steel bar

Fabrication Instructions: See diagram.

Diagram:



Section II. TROUBLESHOOTING

2-3. GENERAL. This section contains troubleshooting information for locating and correcting operating troubles which may develop in the generator set. Table 2-4 contains intermediate and depot level maintenance troubleshooting procedures. Each malfunction for an individual component unit, or system is followed by a list of tests or inspections which will help you to determine probable causes and corrective actions to take. You should perform the tests/inspections and corrective actions in the order listed.

Table 2-4. Troubleshooting

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

ENGINE-GENERATOR SET

1. ENGINE FAILS TO CRANK PROPERLY WHEN START-STOP-RUN SWITCH IS SET TO START (USUAL CONDITIONS).

Inspect ring gear on flywheel (refer to Chapter 11, Section IX).

Replace defective ring gear (refer to Chapter 11, Section IX).

2. ENGINE CRANKS BUT FAILS TO START.

Step 1. Check for defective or improperly set governor (refer to Chapter 11, Section II).

If governor is defective, repair or replace governor as required (refer to Chapter 11, Section II).

If governor is out of adjustment, adjust as required (refer to Chapter 11, Section II).

Step 2. Check for burned valves or sticking valves.

Adjust or replace valves (refer to Chapter 11, Section IV).

Step 3. Check for defective or improperly adjusted governor.

Reset or repair governor, as required (refer to Chapter 11, Section II).

Step 4. Check for defective fuel injection pump.

Repair fuel injection pump as required (refer to Chapter 7, Section III).

Step 5. Check for improperly timed engine.

Reset timing as required (refer to Chapter 11, Section II).

Step 6. Check for clogged fuel supply, clogged filter system, air in system, out of fuel, etc.

Table 2-4. Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

3. GENERATOR OUTPUT VOLTAGE FAILS TO BUILD UP.

Step -1. Defective dc relay assembly, A5 field flash relay K5, in mode I relay box.

a. Test relay (Para 6-10)

Step -2. Defective or improperly adjusted speed switch S9.

a. Repair or adjust switch (Para 4-14)

Step -3. Defective exciter-regulator A10 and A11.

a. Test and replace exciter-regulator if defective (Para 6-15)

Step -4. Shut down engine. Disconnect connector J13 from exciter-regulator A11. Connect the positive output of a dc power supply (variable between 9 and 11 volts and capable of supplying 7 amperes) to terminal R of connector J13. Connect negative lead of power supply to terminal S of J13. Start engine. Vary output of power supply to bring generator output voltage up to required value.

If generator output voltage still fails to build up, shut down engine, disconnect power supply, and refer to Chapter 10, Maintenance of Power Generation System.

Step -5. At current transformer assembly (mounted at side of generator) tag and disconnect leads going to TB-1, -2, -3, and -4 (that is, current transformers CT4, CT5, and CT6). Start engine.

If generator output voltage builds to normal, check and replace CT4, CT5, or CT6 as required (refer to Chapter 6, Section VII)

If generator output voltage still fails to build up, shut down engine and refer to Chapter 6, Section III (exciter-regulator A11 maintenance).

4. GENERATOR OUTPUT VOLTAGE ERRATIC (FREQUENCY IS STABLE).

Step 1. Shut down engine. Disconnect connector J13 from exciter-regulator A11. Connect the positive output of a dc power supply (variable between 9 and 11 volts and capable of supplying 7 amperes) to terminal R of connector J13. Connect negative lead of power supply to terminal S of J13. Start engine. Vary output of power supply to bring generator output voltage up to required value. Monitor generator output voltage for approximately five minutes.

If generator output voltage is stable, shut down engine, disconnect power supply, and refer to Chapter 6, Section III for exciter-regulator A11 maintenance.

If generator output voltage is still erratic, shut down engine, disconnect power supply, and refer to Chapter 10, Maintenance of Power Generation System.

Table 2-4. Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

4. GENERATOR OUTPUT VOLTAGE ERRATIC (FREQUENCY IS STABLE) (Continued)

Step 2. At current transformer assembly (mounted at side of generator) tag and disconnect leads going to TB-1, -2, -3, and -4 (that is, current transformer CT4, CT5, and CT6). Start engine.

If generator output voltage stabilizes, check and replace CT4, CT5, or CT6 as required (refer to Chapter 6, Section VII).

If generator output voltage is still erratic, shut down engine and refer to Chapter 6, Section III.

5. GENERATOR FREQUENCY FAILS TO ATTAIN OR MAINTAIN RATED VALUE.

Step 1. Check governor and associated linkage (refer to the Operator and Organizational Maintenance Manual.

If either governor or linkage is misadjusted or defective (refer to Chapter 11, Section II).

Step 2. Check adjustment of fuel injection pumps (refer to Chapter 7, Section III).

If fuel injection pumps appear to be out of adjustment, refer to Chapter 7, Section III).

6. ENGINE SHUTS DOWN AND LOW OIL PRESSURE FAULT INDICATOR LIGHTS.

Step 1. Check for broken oil lines and loose oil fittings.

If oil lines are broken or fittings loose, replace or adjust as required.

Step 2. Check for defective or worn oil pump (mounted in the crankcase).

If oil pump is worn or defective, repair or replace as required (refer to Chapter 11, Section IV).

Step 3. Check oil level.

Table 2-4. Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

7. ENGINE SHUTS DOWN AND COOLANT HIGH TEMP FAULT INDICATOR LIGHTS.

Step 1. Check for clogged or defective radiator.

If radiator is clogged or defective, repair or replace as required.

Step 2. Check for worn or defective water pump.

If water pump is worn or defective, repair or replace as required (refer to Chapter 8, Section III).

Step 3. Check for incorrectly timed or defective fuel injection pump.

If fuel injection pump is mistimed, reset timing (refer to Chapter 7, Section II).

Step 4. Check tension of fan belts.

8. ENGINE MISSES OR RUNS ERRATICALLY.

Step 1. Check for incorrectly timed fuel injection pump.

If fuel injection pump is mistimed, reset timing (refer to Chapter 7, Section II).

Step 2. Check for worn or defective fuel injection pump.

If fuel injection pump is worn or defective, repair or replace as required (refer to Chapter 7).

Step 3. Check for worn or broken rocker arm assembly.

If rocker arm assembly is worn or broken, repair or replace as required (refer to Chapter 11, Section IV).

Step 4. Check for worn or defective fuel injection nozzles.

If any fuel injection nozzles are worn or defective, repair or replace as required (refer to Chapter 7, Section IV).

Step 5. Check for air in lines.

Table 2-4. Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

9. ENGINE LACKS POWER.

Step 1. Check for incorrect timing of fuel injection pump.

If fuel injection pump is mistimed, reset timing (refer to Chapter 7, Section II).

Step 2. Check for worn or defective fuel injection pump.

If fuel injection pump is worn or defective, repair or replace as required (refer to Chapter 7).

Step 3. Check for worn or defective fuel injection nozzles.

If any fuel injection nozzles are worn or defective, repair or replace as required (refer to Chapter 7, Section IV).

Step 4. Check for clogged filter.

10. ENGINE KNOCKS, DEVELOPS EXCESSIVE NOISE, OR VIBRATION.

Step 1. Check for loose or defective crankshaft pulley or vibration damper.

If crankshaft pulley or vibration damper is loose or defective, tighten or replace as required (refer to Chapter 11, Section X).

Step 2. Check for loose or defective (imbalanced) fan assembly.

If fan assembly is either loose or defective, tighten or replace as required.

Step 3. Check for loose or defective engine mounts.

If engine mounts are either loose or defective, tighten or replace as required (refer to Chapter 2, Section IV).

Step 4. Check for generator rotor unbalance or loose coupling plates.

11. ENGINE EXHAUST EXCESSIVELY BLACK OR GRAY.

Step 1. Check fuel injection pump for incorrect timing.

If fuel injection pump is mistimed, reset timing (refer to Chapter 7, Section II).

Table 2-4. Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

11. ENGINE EXHAUST EXCESSIVELY BLACK OR GRAY (Continued)

Step 2. Check for worn or defective fuel injection nozzles.

If any fuel injection nozzles are worn or defective, repair or replace as required (refer to Chapter 7, Section IV).

12. HEAVY ENGINE COMBUSTION KNOCK.

Step 1. Check for defective fuel injection pump plunger and barrel assembly (refer to Chapter 7, Section III).

If fuel injection pump plunger and barrel assembly is defective, replace as required (refer to Chapter 7, Sections III and IV).

Step 2. Check for defective or leaking fuel injection valve (refer to Chapter 7, Section IV).

If fuel injection valve is either leaking or defective, replace as required (refer to the Operator and Organizational Maintenance Manual).

13. ENGINE STALLS AT LOW SPEED (1500 RPM - 50 HERTZ).

Step 1. Check low idle setting of governor (refer to Chapter 11, Section II).

If low idle setting of governor is incorrect, reset as required (refer to Chapter 11, Section II).

Step 2. Check for defective fuel injection valve (refer to Chapter 7, Section IV).

If fuel injection valve is defective, repair as required (refer to Chapter 7, Section IV).

14. COOLANT IN ENGINE LUBRICATING OIL.

Check for defective cylinder head gasket (refer to Chapter 11, Section IV).

If cylinder head gasket is defective, replace it (refer to Chapter 11, Section IV).

Table 2-4. Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

15. NOISY TURBOCHARGER.

Step 1. Check turbocharger for worn bearings (with engine shut down).

If turbocharger bearings are worn, replace them (refer to Chapter 11, Section I).

Step 2. Check turbocharger for sufficient lubrication.

If turbocharger is not getting sufficient lubrication, clean oil passages (refer to Chapter 11, Section I).

Step 3. Check turbocharger for excessive end play (refer to Chapter 11, Section I).

If turbocharger end play is excessive, repair turbocharger as required (refer to Chapter 11, Section I).

Step 4. Check shaft and wheel assembly of turbocharger (refer to Chapter 11, Section I).

If shaft and wheel assembly is defective, repair as required (refer to Chapter 11, Section I).

GOVERNOR

1. ENGINE HUNTS OR SURGES.

NOTE

Hunting is a rhythmic variation of speed which can be eliminated by blocking governor operation manually but will recur when returned to governor control. Surge is a rhythmic variation of speed, always of large magnitude, which can be eliminated by blocking governor action manually and which will not recur when returned to governor control, unless speed adjustment is changed or the load changes.

Step 1. Check for incorrectly mounted governor.

Loosen governor on pad and realign. Tighten attaching nuts evenly to proper torque value.

Table 2-4. Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

1. ENGINE HUNTS OR SURGES (Continued)

NOTE

Do not confuse high frequency vibration of the governor terminal shaft and fuel linkage with normal controlling action of governor.

Step 2. Check for rough engine drive.

Check drive alignment (refer to Chapter 11).

Check drive eccentricity or excessive backlash (refer to Chapter 11).

Check shaft mountings for looseness (refer to Chapter 11).

Check vibration dampener (refer to Chapter 11).

Check load for cyclic variation.

Step 3. Inspect that compensation needle valve (84, figure 11-5) is not opened too far.

Adjust needle valve as described in Chapter 11, Section II.

Step 4. Check for dirty or foaming oil (causing power piston (49, figure 11-5) to stick)).

Remove and drain governor and flush with fuel oil or kerosene. Check oil supply system for air entrainment and proper type of oil. Clean or replace filter. Change oil. Disassemble governor, if necessary, and clean.

Step 5. Check for improper relationship between governor output shaft travel and engine power output.

Governor shaft travel to power output should be approximately linear. Readjust or rework linkage to obtain a linear relationship between engine horsepower and output shaft position (refer to Chapter 11, Section II).

Step 6. Check for excessive backlash or binding in linkage.

Repair linkage (refer to the Operator and Organizational Maintenance Manual).

Table 2-4. Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

1. ENGINE HUNTS OR SURGES (Continued)

Step 7. Check governor for negative droop.

Set correct percentage of positive droop (refer to Chapter 11, Section II).

Step 8. Check governor case for excessive oil. Check case drain line or drain through pilot valve bushing for restrictions.

Clean drain passages and rework the drive to the governor to provide unrestricted drain. No back pressure is tolerated. Also the drain passages in the case cavity must be free of back pressure (refer to Chapter 11, Section II).

Step 9. Check for fatigued or broken buffer spring(s) (51 and 52, figure 11-5).

Replace springs (refer to Chapter 11, Section II).

Step 10. Check governor parts for wear (excessive internal leakage) or incorrect adjustments.

Refer to Chapter 11, Section II for inspection and replacement of governor parts.

Step 11. Check for sticking power piston (49, figure 11-5) in cylinder.

Repair if possible by cleaning and polishing; otherwise replace.

Step 12. Check for failure of spring-driven ballhead (67, figure 11-5).

Remove ballhead assembly (63 through 70, figure 11-5) and check operation of torsion spring (65). Disassemble and clean parts. Replace entire ballhead assembly if any of its parts prove to be defective.

Table 2-4. Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

2. FUEL CONTROL DOES NOT OPEN SUFFICIENTLY OR QUICKLY DURING STARTING.

Step 1. Check governor oil supply system for restrictions or foaming oil.

Eliminate restrictions. Clean or replace filter. Check for proper oil viscosity. Change oil.

Step 2. Check governor oil pressure relief valve (View A, figure 11-5) for sticking plunger (90), fatigued or broken spring (89).

Free plunger. Replace worn or damaged parts.

Step 3. Inspect pump check valves (79, figure 11-5) for proper operation.

Clean or replace leaking check valves.

Step 4. Check governor pump gears (74 and 75, figure 11-5) and gear pockets for excessive wear.

Replace worn parts.

3. ENGINE SLOW TO RESPOND TO LOAD OR SPEED CHANGES.

Step 1. Check setting of compensation needle valve (85, figure 11-5).

Adjust needle valve (refer to Chapter 11, Section II).

Step 2. Check engine loading.

Reduce engine load to rated value.

Step 3. Check compensation buffer piston (50, figure 11-5) for sticking.

Remove governor and clean it thoroughly (refer to Chapter 11, Section II). Reinstall governor and clean or replace filter in oil supply system.

Step 4. Check governor case for excessive oil: case drain line or drain through pilot valve bushing (59, figure 11-5) may be plugged or restricted.

Table 2-4. Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

3. ENGINE SLOW TO RESPOND TO LOAD OR SPEED CHANGES (Continued)

Clean drain line or drain passages in pilot valve bushing. Rework the drive to the governor to provide unrestricted drain (refer to Chapter 11, Section II).

Step 5. Check for low governor oil pressure.

Check governor oil supply system for restrictions or foaming oil. Eliminate restrictions. Clean or replace filter. Check for proper oil viscosity. Change oil (refer to Chapter 11, Section II).

Step 6. Check governor oil pressure relief valve (View A, figure 11-5) for sticking plunger (90), fatigued or broken spring (89).

Free plunger. Replace worn or damaged parts.

Step 7. Inspect pump check valves for proper operation.

Clean or replace leaking check valves.

Step 8. Check governor pump gears (74 and 75, figure 11-5) and gear pockets for excessive wear.

Replace worn parts.

Step 9. Check for incorrect buffer springs (51 and 52, figure 11-5) in governor.

Install correct buffer springs.

Step 10. Check for restricted fuel supply or overloaded engine.

Clean fuel filters and fuel supply lines. Reduce load.

4. NO OUTPUT FROM GOVERNOR.

Step 1. Check for sticking power piston (49, figure 11-5) due to dirty oil.

Remove and drain governor and flush with fuel oil or kerosene. Clean or replace filter in oil supply system. Change oil. Disassemble governor, if necessary, and clean.

Table 2-4. Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

4. NO OUTPUT FROM GOVERNOR (Continued)

Step 2. Check oil supply system for insufficient pressure.

Eliminate restrictions. Clean or replace filter. Check for proper oil viscosity. Change oil.

Step 3. Check governor oil pressure relief valve (View A, figure 11-5) for sticking plunger (90), fatigued or broken spring (89).

Free plunger. Replace worn or damaged parts.

Step 4. Inspect pump check valves (79, figure 11-5) for proper operation.

Clean or replace leaking check valves.

Step 5. Check governor pump gears (74 and 75, figure 11-5) and gear pockets for excessive wear.

Replace worn parts.

Step 6. Check for failure of drive to governor.

Repair the drive to the governor (refer to Chapter 11).

Step 7. Check for damage to internal governor parts.

Disassemble governor (refer to Chapter 11, Section II) and replace damaged parts.

Step 8. Check for binding or misadjusted linkage.

Repair or readjust linkage.

Table 2-4. Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

5. IMPROPER LOAD DIVISION BETWEEN PARALLED UNITS (ONE UNIT ON ZERO DROOP - ALL OTHERS ON DROOP).

Step 1. Check for incorrect speed droop setting on one or more of the droop units.

Increase droop on affected units until load remains steady on each droop unit. System load variation is absorbed by the lead unit with zero droop. Droop units assist in correcting speed deviations on large load changes, but return to their original loads after the load change is absorbed by the lead unit.

Step 2. Check for different speed settings among the droop units.

6. IMPROPER LOAD DIVISION BETWEEN PARALLELED UNITS (ALL UNITS ON DROOP).

Check for incorrect speed droop setting one one or more units.

Adjust droop on each unit until desired division of load is obtained. Increasing droop results in the unit taking a smaller share of load changes; decreasing droop, a larger share.

Section III. GENERAL MAINTENANCE

2-4. GENERAL. This section contains general instructions on repair practices such as cleaning, connecting and disconnecting wires, soldering, and welding.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eyes, and respiratory protection is required.

WARNING

Compressed air used for cleaning or drying can create airborne particles that may enter the eyes. Pressure shall not exceed 30 psig (207 kPa). Wearing of goggles is required.

2-5. CLEANING. Components may be cleaned with low pressure compressed air, then wiped clean with dry, lint-free cloth. Components may also be cleaned with a cloth dampened in cleaning solvent (P-D-680, Type II).

2-6. WIRING. Tag all wires and cables during removal procedures for correct identification during replacement procedures. Before a part is unsoldered, note the position of the leads. If the part has several leads, tag each of the leads before unsoldering any of them. If wiring must be replaced, use leads of the same length and gage. Never use replacement wire with a higher gage number (smaller diameter).

WARNING

Avoid breathing fumes generated by soldering. Eye protection is required. Remove rings and watches while soldering.

2-7. SOLDERING. On printed circuit boards, use a pencil-type soldering iron with a 25-watt maximum heating capacity. Make well-soldered connections, using no more solder than is necessary. Do not allow drops of solder to fall into the unit. Do not allow a soldering iron to come into contact with insulation or other parts that may be damaged by excessive heat. Do not disturb the setting of any uncalibrated control without predetermining its proper setting prior to reenergizing the equipment.

WARNING

Welding operations produce heat, highly toxic fumes, injurious radiation metal slag, and airborne particles. Welding goggles, the proper tinted lenses, apron, or jacket, and welder's boots are required.

2-8. WELDING. Proper preparation is an important factor in welding. Edges to be joined must be clean. Necessary arrangements for holding parts in proper alignment during welding should be made. Oil, grease, paint, or foreign matter of any kind must be removed. With edges properly prepared for welding, the steps should be taken to make certain that the finished job will be in correct alignment.

Section IV. REMOVAL AND INSTALLATION OF MAJOR COMPONENTS

2-9. GENERAL. This section contains instructions for the removal and installation of major components of the generator set required for repair and/or overhaul. Refer to the appropriate subsequent chapters of this manual for maintenance procedures for the removed component.

2-10. REMOVAL AND INSTALLATION OF CONTROL CUBICLE. Refer to the Operator and Organizational Maintenance Manual.

2-11. REMOVAL OF GENERATOR. To remove generator G1 refer to figure 2-1 and the Operator and Organizational Maintenance Manual and proceed as follows:

WARNING

Disconnect negative battery cable to prevent either accidentally starting the generator set or damaging components.

a. Remove housing structure rear cover.

b. Remove both rear access doors.

c. Disconnect and tag all connectors attached to rear housing (14).

NOTE

Position and secure all disconnected cables and plugs away from the generator to facilitate its removal.

d. Disconnect engine manual speed control linkage from governor and secure it against rear housing structure.

e. Remove both upper side housings (5) by removing four screws (2), four nuts (1), four screws (4), and four nuts (3).

f. Check that all wires, cable clamps, etc. are disconnected from rear housing (14).

WARNING

Use heavy duty work gloves to avoid injury to personnel.

g. Remove screws (6, 10, and 13) and, using the required number of personnel, lift rear housing (14) clear of generator set.

h. Remove auxiliary fuel hose and kit mount from skid base on left side of generator by removing two screws and nuts.

i. Disconnect and tag all heavy duty cables coming from generator G1.

j. Refer to figure 2-2 and remove exciter-regulator and document stowage box (3), Mode I relay box (6), transformer assembly cover (10), bracket (16), reconnection board assembly (20), transformer assembly (25), tactical relay box and bracket assembly (28), and main circuit breaker assembly (33).

NOTE

Move reconnection board assembly (20) out far enough to permit access to wiring.

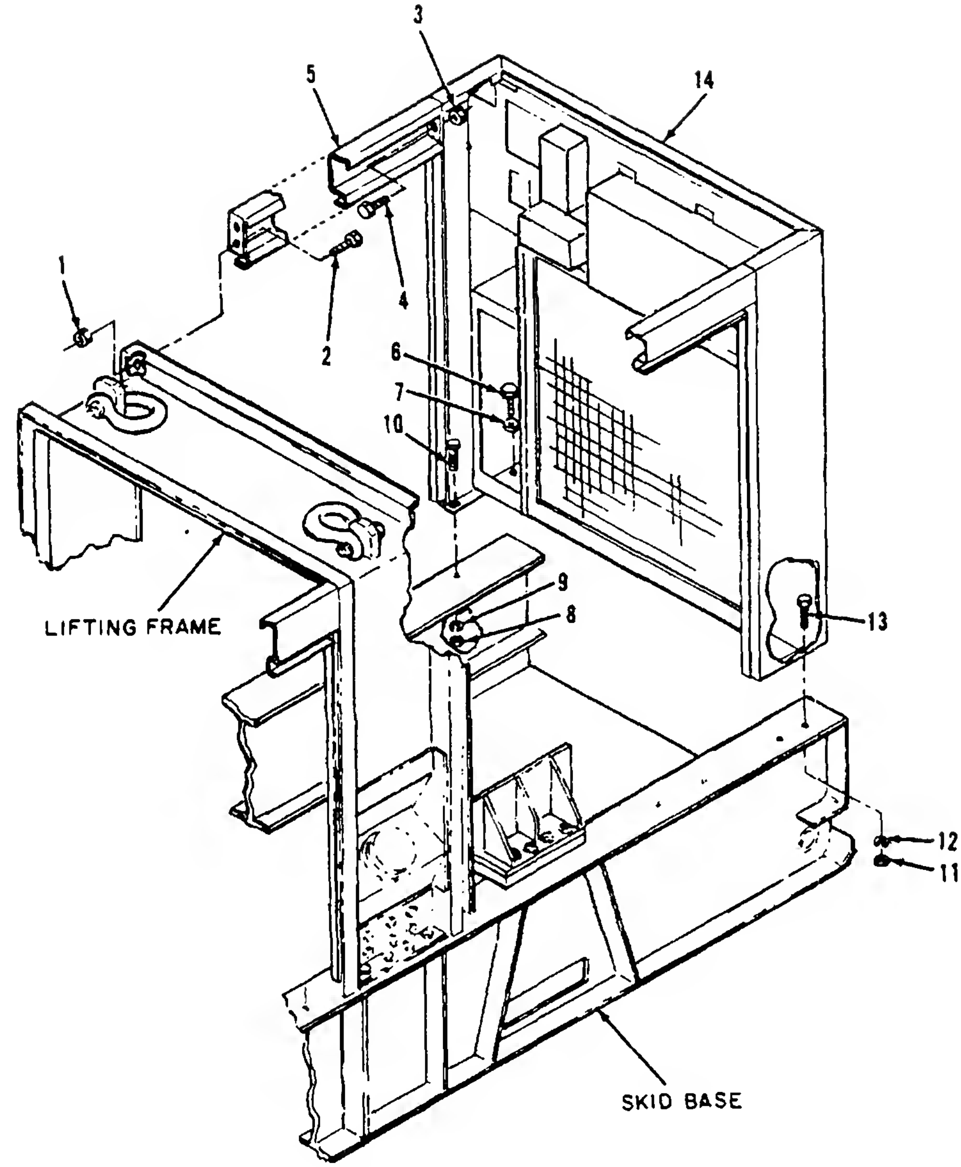
k. Tag and disconnect ground cable from skid base.

l. Tag and disconnect Mode I relay box to reconnection board wiring harness from connector J61 of the generator and terminals of TB2 located on transformer assembly (25).

m. Remove air cleaner and bracket.

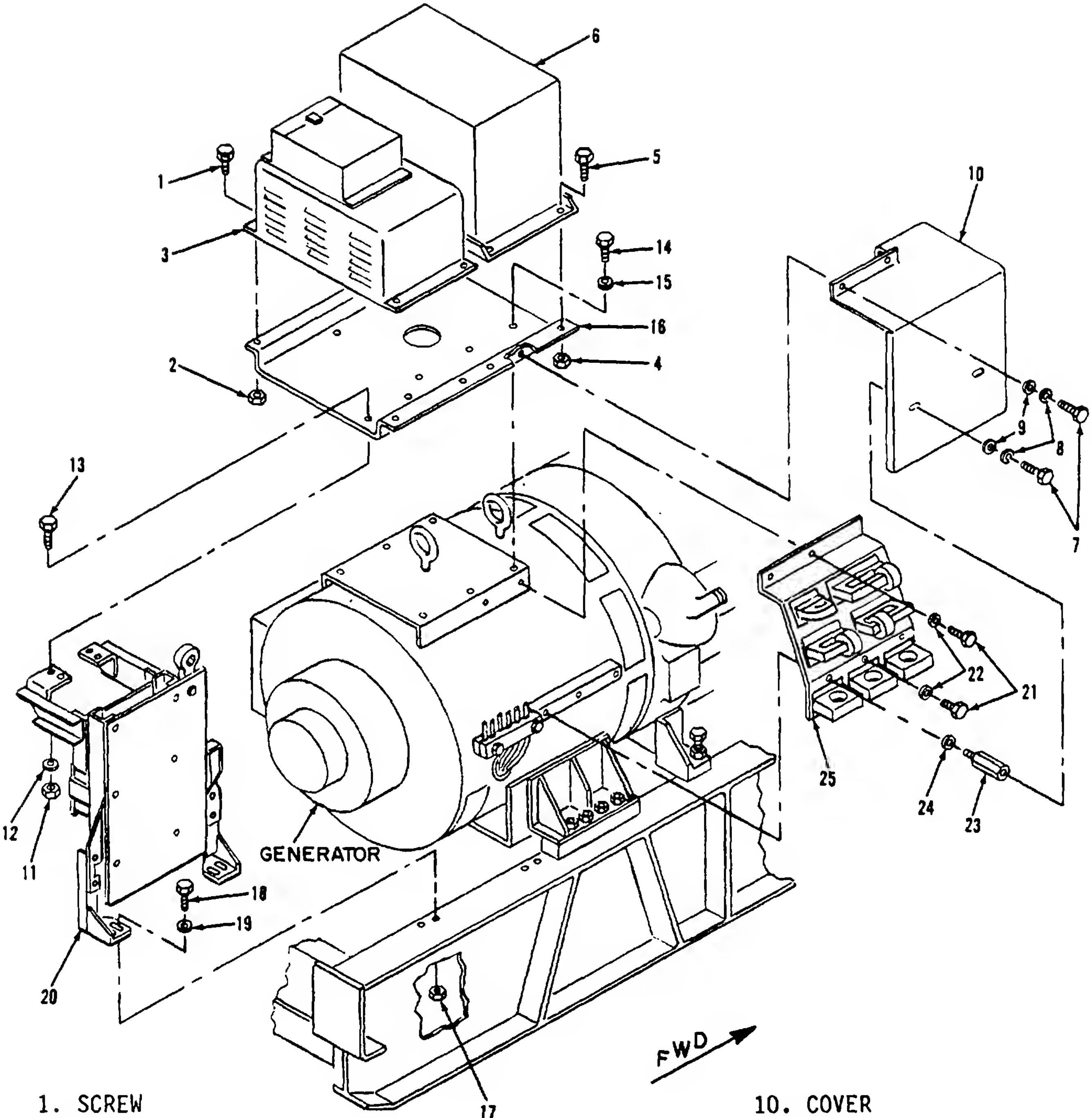
n. Remove turbocharger.

o. Remove and tag generator leads from transformer assembly



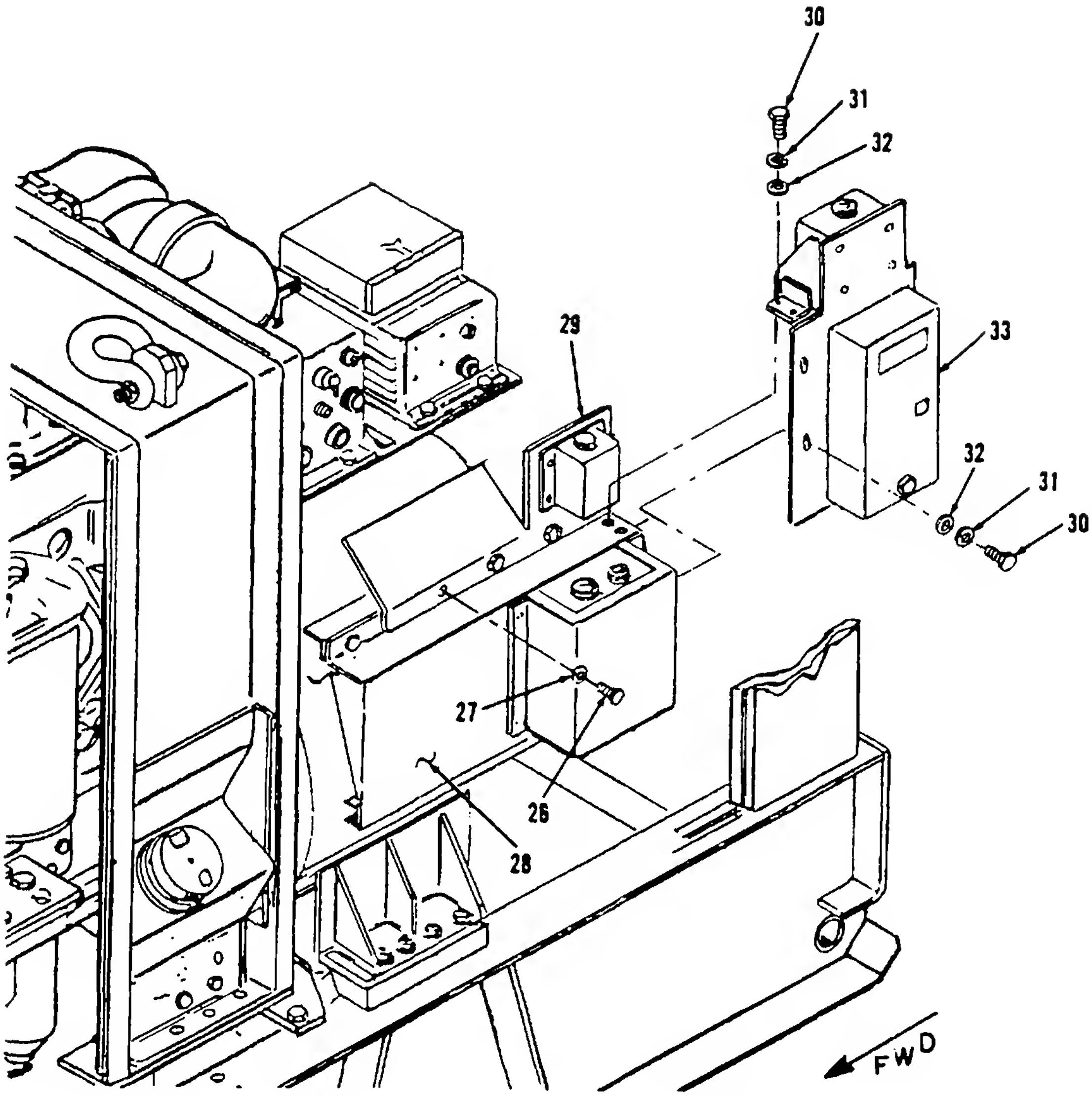
1. NUT
2. SCREW
3. NUT
4. SCREW
5. UPPER SIDE HOUSING
6. SCREW
7. WASHER
8. NUT
9. WASHER
10. SCREW
11. NUT
12. WASHER
13. SCREW
14. REAR HOUSING

Figure 2-1. Rear Housing and Upper Sides Housing, Removal and Installation



1. SCREW
2. NUT
3. EXCITER-REGULATOR AND STOWAGE BOX
4. NUT
5. SCREW
6. MODE I RELAY BOX
7. SCREW
8. LOCKWASHER
9. WASHER
10. COVER
11. NUT
12. WASHER
13. SCREW
14. SCREW
15. WASHER
16. BRACKET
17. NUT
18. SCREW

Figure 2-2. Generator Controls, Removal and Installation (Sheet 1 of 2)



19. WASHER	27. WASHER
20. RECONNECTION BOARD ASSY	28. RELAY BOX AND BRACKET
21. SCREW	29. BRACKET
22. WASHER	30. SCREW
23. STEPPED SPACER	31. LOCKWASHER
24. WASHER	32. WASHER
25. TRANSFORMER ASSY	33. CIRCUIT BREAKER ASSY
26. SCREW	

Figure 2-2. Generator Controls, Removal and Installation (Sheet 2 of 2)

p. Refer to figure 2-3 and disconnect screen (4) and cover plate (18) by removing nuts (1), lockwashers (2), and screws (3) on both sides of generator.

CAUTION

Rotate engine crankshaft as required to gain access to screws (5), which secure generator drive plate to engine flywheel. Do not attempt to rotate generator by prying on generator fan.

q. Straighten corners of locking plates (6) and remove screws (5) and locking plates. Rotate engine crankshaft *using a barring tool on* crankshaft pulley bolt. Turn engine clockwise (standing in front of engine looking toward generator) as required for access to screws (5).

r. Connect an overhead lifting device with a capacity of 3 tons (2.7 t) to both generator lifting eyebolts and remove slack from lifting device. Remove screws (9) and lockwashers (10). Loosen engine support bolt locknuts (16).

NOTE

If it is necessary to remove generator mounting bolts, the fuel tank must be removed.

s. Remove nuts (7) and washer (8) and permit mounting bolts (17) to rest on fuel tank.

t. Lift generator with overhead lifting device (with a 3-ton (2.7 t) capacity) until generator just clears generator mounting bolts. Tighten engine support bolt locknuts (16).

CAUTION

Do not lower generator on mounting bolts; weight of generator on bolts may damage fuel tank.

u. Install two wooden blocks, 180 degrees apart, between generator frame and generator fan to prevent main rotor assembly from sliding out of frame during lifting.

WARNING

Stay clear of generator during lifting operations.

v. Remove generator from generator set.

w. Lower generator to floor and block generator to prevent tipping; removing lifting device from generator.

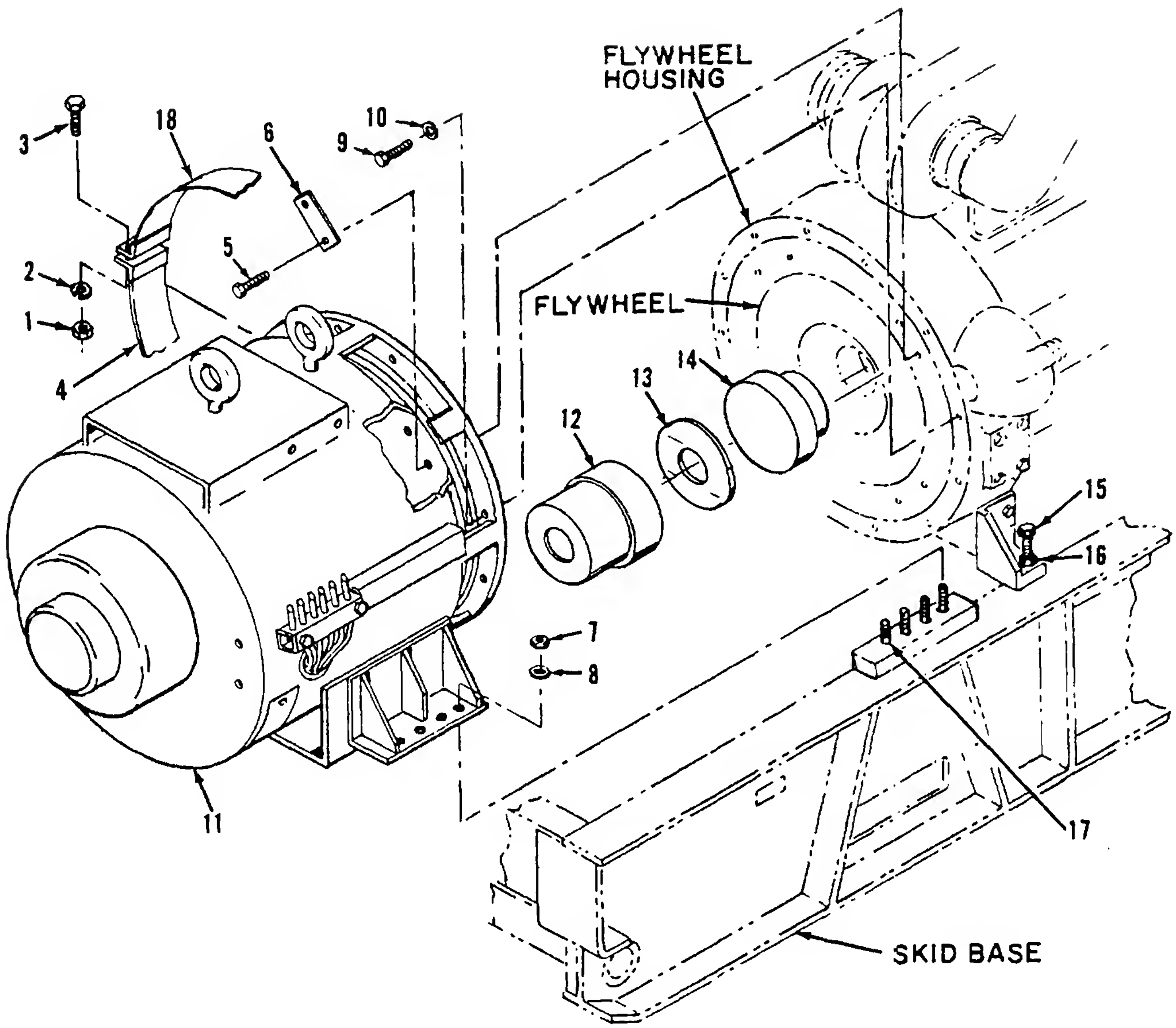
x. Remove wooden blocks installed between generator frame and fan. Secure fan to shaft couplings with two nuts and screws 180 degrees apart.

y. Install screen (4) on generator with screws (3), lockwashers (2), and nuts (7).

z. Install a suitable moving block (refer to table 2-3) across engine mounting end of generator frame to support main rotor assembly and prevent it from sliding out of frame during movement.

aa. Place tag on generator indicating that fan is mounted to shaft coupling with two screws and nuts for moving purposes only.

2-12. INSTALLATION OF GENERATOR. To install generator G1, refer to figures 2-1, 2-2, and 2-3, and the Operator and Organizational Maintenance Manual and proceed as follows:



1. NUT	10. LOCKWASHER
2. LOCKWASHER	11. GENERATOR
3. SCREW	12. SPACER
4. SCREEN	13. SPRING WASHER
5. SCREW	14. SPACER
6. LOCKING PLATE	15. ENGINE SUPPORT BOLT
7. NUT	16. LOCK NUT
8. WASHER	17. MOUNTING BOLT
9. SCREW	18. COVER PLATE

Figure 2-3. Generator, Removal and Installation

a. Move generator as close to generator set as possible. Remove shipping blocks, screws, and nuts.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

b. Make sure spacers (12 and 14, figure 2-3) and spring washer (13) are installed in flywheel. Clean flywheel with an cleaning solvent (P-D-680, Type II) and dry thoroughly. Inspect flywheel for nicks and burrs. Remove nicks and burrs using a suitable file or stone.

c. Remove screen (4) from generator. If fan is bolted to shaft couplings, remove shipping screws and nuts.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

d. Inspect generator shaft couplings for ragged edges and burrs. Touch up ragged edges and burrs with a file, exercising care to remove burrs and ragged edges only. Clean shaft and couplings with cleaning solvent (P-D-680, Type II) and dry thoroughly.

e. Install two wooden blocks, 180 degrees apart, between generator frame and fan to prevent main rotor assembly from sliding out of frame during installation.

f. Connect a overhead lifting device (with a 3-ton (2.7 t) capacity) to both generator lifting eyebolts.

WARNING

Stay clear of generator during lifting.

g. Position generator against flywheel housing and secure generator with two screws (9) and washers (10), 180 degrees apart.

h. Remove wooden blocks from generator frame. Rotate engine crankshaft using a barring tool on engine crankshaft pulley bolt to align flywheel generator shaft coupling holes with holes in shaft couplings. Turn engine clockwise (standing in front of engine looking toward generator). After holes are aligned, push generator shaft couplings against engine flywheel, making sure couplings are inside of flywheel recess. Loosen engine bolts.

NOTE

Rotate engine crankshaft as required to gain access to screws.

i. Position generator fan on rear of shaft couplings and install locking plates (6) and screws (5). Tighten screws evenly in a criss-cross pattern. Torque screws to 150 foot-pounds (240 Newton-meters). Bend corners of locking plates (6) against screws (5) to prevent screws from turning.

j. Install remaining screws (9) and washers (10). Torque screws to 75 foot-pounds (102 Newton-meters).

CAUTION

Take care not to lower generator on mounting bolts; weight of generator on bolts may damage fuel tank.

k. Simultaneously lower generator and engine using overhead lifting device until generator mounts are just above generator mounting bolts.

l. Push generator toward radiator until generator mount holes are in alignment with mounting bolts. Push mounting bolts up through generator mounting holes and install washers (8) and nuts (7). Lower generator and engine onto skid base. Remove overhead lifting device. Hold generator mounting bolts stationary and tighten nuts (7) to 500-550 foot-pounds(69 - 76 KGM) torque.

m. Check generator for air gap of 0.125 inches (3.175 mm) using three plastic gages approximately 1 foot long (0.3 meters). Equally space gages (see table 2-2) and insert gages through opening between generator frame and fan. Position gages between main stator and main rotor, making sure gages are positioned on high points of stator pole splices. Hold gages stationary and rotate engine crankshaft and generator approximately three revolutions. Remove and inspect gages. Gages should not show any signs of interference. If interference is indicated, generator is defective or engine flywheel is not concentric.

n. Install screen (4) and secure with screws (3), washer (2), and nuts (1). Tighten engine bolts.

o. Refer to figure 2-2 and install tactical relay box and bracket assembly (28), transformer assembly (25), reconnection board assembly (20), bracket (16), cover (10), Mode I relay box (6), and exciter regulator and stowage box (3).

NOTE

For wire routing and termination, refer to the Operator and Organizational Maintenance Manual.

p. Install transformer assembly (25) and route generator leads through transformers.

q. Connect relay box to reconnection board wiring harness and generator leads to reconnection board assembly. Secure reconnection board assembly to skid base.

r. Connect relay box to reconnection board harness to connector J41 of the load contactor, J61 of the generator, and terminal board TB2 located on transformer assembly.

s. Position auxiliary fuel hose and mount on skid base at left side of generator and secure with two screws and nuts.

t. Install turbocharger.

u. Refer to figure 2-1 and install upper side housings (5) and assembled rear housing (14).

v. Install and adjust manual speed control.

w. Connect wiring harnesses to fault indicator, DC control circuit breaker, control cubicle, convenience receptacle, exciter-regulator, mode I relay box, load measurement units, tactical relay box, and kit control box, if installed.

x. Install air cleaners and bracket.

y. Install rear housing cover and generator compartment access doors.

z. Connect negative battery cable.

2-13. REMOVAL OF ENGINE. To remove engine, refer to figures 2-1 through 2-4 and the Operator and Organizational Maintenance Manual and proceed as follows:

a. Drain primary fuel filter and strainer, secondary fuel filter, day tank, radiator, and engine lubricating oil.

b. Disconnect negative battery cable. Tag and disconnect cables from slave receptacle SR2, and starter assembly B1. Remove starter ground cable from skid base.

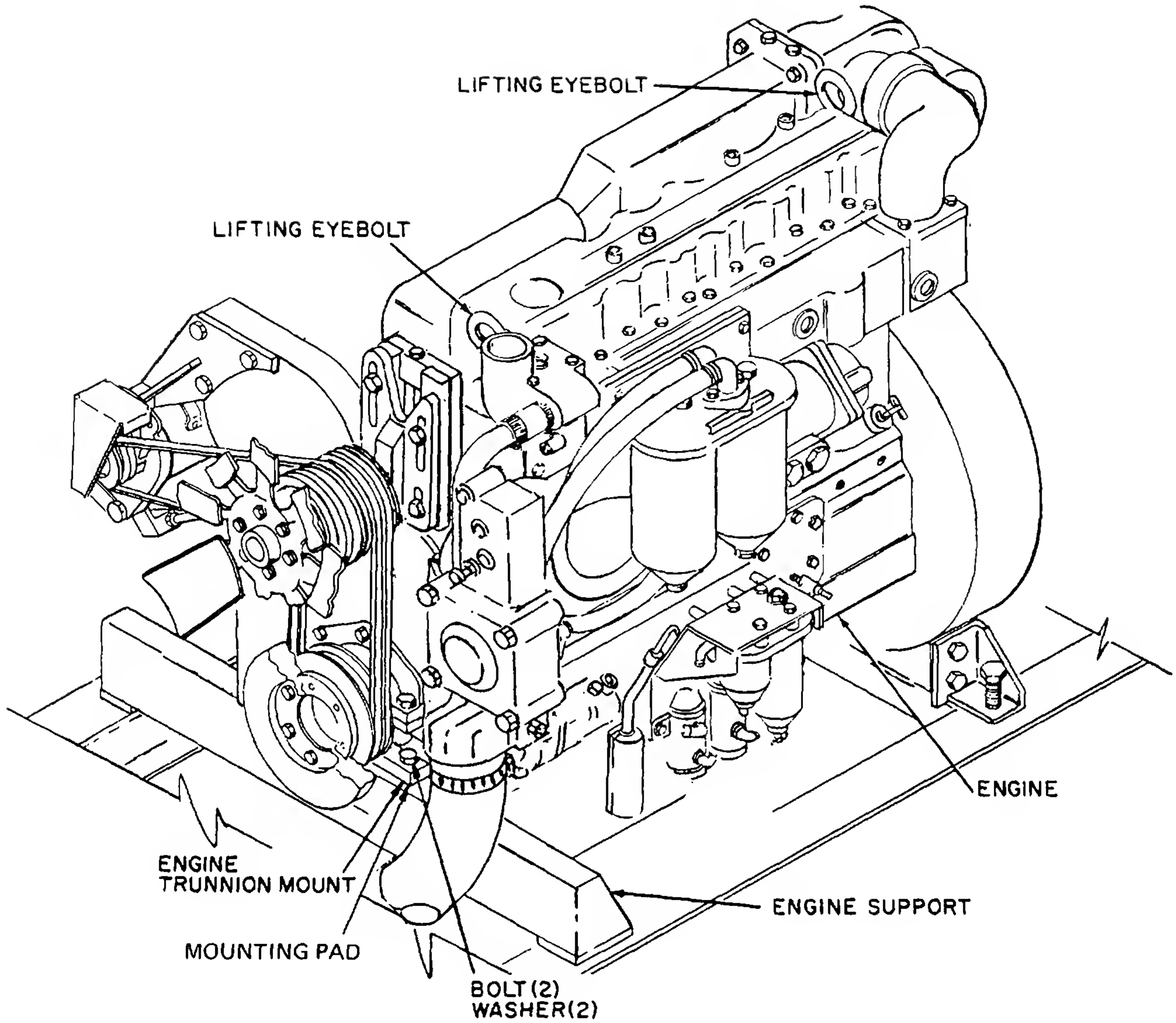


Figure 2-4. Engine Removal and Installation

c. Disconnect muffler clamps from front housing cover. Remove front and rear housing covers, engine, generator, and battery compartment access doors.

d. Remove muffler, exhaust pipe, and crankcase breather tube. Remove engine breather assembly.

e. Remove radiator and shutter.

f. Disconnect manual speed control from governor input shaft and lifting frame bracket.

g. Remove air cleaner.

h. If installed, remove winterization kit heaters and coolant lines from oil pan heat exchanger tubes and engine block. Disconnect kit harnesses from control boxes and coil harness on engine.

i. Tag and disconnect engine harness from connector J5 of Mode I relay box, connector J39 of DC control circuit breaker, connector J33 of the day tank float switch, connector J38 of the ether primer and fuel tank fuel level transmitter. Cut tiedown strap securing engine harness to other harnesses. Coil engine harness wires and secure wires to engine.

j. Disconnect ether starting aid tube from atomizer at rear of cylinder head inlet elbow.

k. Tag and disconnect electrical leads from radio suppression diode assembly mounted to day tank.

l. Disconnect four upper side housing members from lifting frame by removing eight screws and nuts securing members to lifting frame.

m. Remove two members from rear housing by removing four screws and washers.

n. Disconnect engine oil drain hose from engine oil drain valve at left side of engine. Plug hose and valve opening.

o. Remove engine block coolant drain hose from right side skid base fitting.

p. Loosen clamp and remove fuel filler hose from fuel tank. Cover fuel tank opening. Disconnect fuel tank vent hoses from fuel filler neck. Tag and disconnect fuel hoses from fuel transfer valve, auxiliary fuel inlet fitting, fuel supply outlet fitting and day tank. Remove supply hose from electric fuel transfer pump. Plug hoses. Disconnect two clamps securing hoses to lifting frame; one clamp is located on each inside wall of lifting frame.

q. Remove sixteen screws, washers, and nuts securing lifting frame to skid base. Using a suitable lifting device, remove lifting frame from generator set.

r. Tag and disconnect electrical connectors from exciter-regulator. Disconnect exciter-regulator and stowage box (3, figure 2-2) by removing nuts (1) and screws (2). Remove nuts (11 and 17), screws (13 and 18), and washers (12 and 19). Move reconnection board assembly (20) away from bracket (16).

s. Disconnect screen (4, figure 2-3) by removing nuts (1), washers (2), and screws (3).

t. Disconnect auxiliary fuel hose and mount from skid base at left rear of generator by removing screws and nuts.

CAUTION

Rotate engine crankshaft as required to gain access to screws. Do not attempt to rotate generator by prying on generator fan.

u. Straighten corners of locking plates (6) and remove screws (5) and locking plates. Rotate engine crankshaft using a barring tool on crankshaft pulley bolt. Turn engine clockwise (standing in front of engine looking toward generator) as required for access to screws (5). Hold barring tool stationary to permit loosening screws.

v. Remove nuts (7) and washers (8) and permit generator mounting bolts to rest on fuel tank.

w. Connect a overhead lifting device (with a 5-ton (4.5 t) capacity) to both engine lifting eyebolts (figure 2-4). Remove slack from lifting device.

x. Disconnect engine trunnion mount from engine support by removing bolts and washers.

WARNING

Stay clear of engine during lifting.

CAUTION

During lifting operations, check that generator mounting bolts are not binding on generator mount.

y. Slowly raise lifting device, pivoting front of engine up until there is sufficient clearance for engine oil pan to clear engine support.

z. Support front of engine to prevent it from swinging forward when generator-to-flywheel housing bolts are removed.

CAUTION

Generator must be blocked so that generator weight is on skid base.

aa. Block generator in raised position with suitable blocks that contact each side of the skid base.

ab. Remove screws (9, figure 2-3) and washers (10) securing generator to flywheel housing.

WARNING

Stay clear of engine during lifting.

ac Remove support from front of engine and move engine free of generator. Remove engine from generator set and place on stand, cradle, or crib and block.

ad. If necessary, remove spacers (12 and 14) and spring washer (13) from flywheel.

WARNING

Steam or vapor pressure cleaning creates hazardous noise levels and severe burn potential. Skin, eye, and ear protection is required.

ae. Plug all engine openings and steam clean engine.

2-14. INSTALLATION OF ENGINE. To install engine refer to figures 2-1 through 2-4 and the Operator and Organizational Maintenance Manual, and proceed as follows:

a. Move engine as close to generator set as possible.

b. Connect a lifting device (with a 5-ton (4.5 t) capacity to both engine lifting eyebolts (figure 2-4).

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

c. Inspect flywheel for nicks and burrs on generator contact surfaces. Remove nicks and burrs using a suitable file or stone. Clean flywheel with cleaning solvent (P-D-680, Type II) and dry thoroughly.

d. Insert spacers (12 and 14, figure 2-3) and spring washer (13) in flywheel.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

e. Inspect generator shaft couplings for ragged edges and burrs. Touch up ragged edges and burrs with a file, exercising care to remove burrs and ragged edges only. Clean shaft couplings with cleaning solvent (P-D-680, Type II) and dry thoroughly.

WARNING

Stay clear of engine during lifting operation.

f. Position engine in generator set, aligning engine flywheel housing screw holes with generator frame holes. Install four screws (9, figure 2-3) and washers (10), 90 degrees apart.

g. Raise lifting device so that block can be removed from beneath generator. Remove block and slowly lower engine in place so that engine support bolt holes (figure 2-4) and trunnion mount holes are in alignment. Secure trunnion mount to engine support with bolts and washers. Make sure generator mounting bolts are in alignment with generator mount holes and tighten engine mount bolts to 200 foot-pounds (271 Newton-meters) torque.

h. Remove four screws securing generator to engine to permit engine to move forward.

i. Rotate engine crankshaft using suitable engine barring tool on crankshaft pulley bolt to align flywheel generator shaft coupling holes with holes in generator shaft couplings. Turn engine crankshaft clockwise (standing in front of engine looking toward generator). After holes are aligned, push generator shaft couplings against engine flywheel, making sure couplings are inside of flywheel recess.

NOTE

Rotate engine crankshaft as required to gain access to screws.

j. Position generator fan on rear of shaft couplings and install locking plates (6, figure 2-3) and screws (5). Tighten screws evenly in a criss-cross pattern. Torque screws to 75 foot-pounds (102 Newton-meters). Bend corners of locking plates (6) against screws (5) to prevent screws from turning.

k. Install screws (9) and washers (10). Tighten screws evenly and to 150 foot-pounds (204 Newton-meters) torque.

l. Push mounting bolts up through generator mounting holes and install washer (8) and nuts (7). Hold generator mounting bolts stationary and tighten nuts (7) to 600-foot pounds (813 Newton-meters) torque.

NOTE

Generator air gap should be 0.125 inch (3.175 mm).

m. Check generator air gap using three plastic measuring strips approximately 1 foot (0.3 meter) long (refer to table 2-2). Equally space strips and insert through opening between generator frame and fan. Position strips between main stator and main rotor, making sure strips are positioned on high points of stator pole pieces. Hold strips stationary and rotate engine and generator approximately three revolutions by turning engine crankshaft. Remove and

inspect measuring strips. Strips should not show any signs of interference. If interference is indicated, generator is defective or engine flywheel is not concentric.

n. Install screen (4) and secure with screws (3), washer (2), and nuts (1).

o. Secure reconnection board assembly (20, figure 2-2) to skid base and bracket (16) with screws (13 and 18), washers (12 and 19), and nuts (11 and 17). Install exciter-regulator and stowage box and secure with screws (1) and nuts (2). Connect electrical connectors to exciter-regulator.

p. Using a lifting device (with a 10-ton (9.07 t) capacity), position lifting frame on generator set skid base. Secure lifting frame to skid base with sixteen screws, washers, and nuts.

q. Connect fuel filler hose to fuel tank and secure with clamp. Connect fuel tank vent hoses to fuel filler neck. Connect fuel hoses to fuel transfer valve, auxiliary fuel inlet fitting, fuel supply outlet fitting, day tank, and electric fuel transfer pump. Clamp hose to lifting frame.

r. Connect engine block coolant drain hose to skid base fitting and secure with clamp.

s. Connect engine oil drain hose to engine oil drain valve.

t. Connect four upper side housing members to lifting frame and secure eight screws and washers. Connect two members to rear housing and secure with four screws and washers.

u. Connect three electrical leads to radio suppression diode assembly.

v. Connect ether starting tube to atomizer at rear of cylinder head inlet elbow.

w. Connect engine harness to connector J5 of Mode I relay box, connector J33 of day tank float valve, connector J38 of ether primer, connector J39 of DC control circuit breaker, and fuel tank fuel level send unit. Fasten harness to other harness with tiedown straps.

x. If required, install winterization kit heaters and coolant lines. Connect kit harnesses to control boxes.

y. Install air cleaner.

z. Connect and adjust manual speed control.

aa. Install radiator and shutter.

ab. Install engine crankcase breather, crankcase breather tube, muffler, and exhaust pipe.

ac. Install front and rear housing covers; battery, engine, and generator compartment access doors. Connect muffler clamps to front housing cover.

ad. Connect starter ground cable to skid base. Connect cables to slave receptacle SR2. Install negative battery cable.

ae. Start engine and bleed fuel system.

CHAPTER 3

MAINTENANCE OF HOUSING

Section I. MAINTENANCE OF ACCESS DOORS, PANELS, AND COVERS

3-1. GENERAL. Access doors are provided for the control cubicle, air intake louver assembly, battery compartment, and each side of the generator set for service purposes. Each access door contains seal paddle locks and door rods to hold the door open. The battery access cover may be held open by means of a door holder attached to the radiator grille. Shutter assemblies are mounted on the left and right front access doors.

3-2. REPAIR.

a. Removal. Refer to Operator and Organizational Maintenance Manual and remove the access doors. Front and rear cover, and filler panels.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

b. Cleaning. Clean components with cleaning solvent (P-D-680, Type II) and dry thoroughly.

c. Repair.

(1) Straighten bent door rods.

(2) Replace damaged or defective door latch in accordance with paragraph 3-11.

(3) Replace damaged door seals.

WARNING

Paint is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

(4) Scrape damaged paint. Blend in edges, prime, and paint (olive drab, per MIL-T-704, Type A, semi-gloss, No. X24087) damaged areas.

d. Installation. Refer to Operator and Organizational Maintenance Manual.

Section II. MAINTENANCE OF RADIATOR GRILLE

3-3. GENERAL. The radiator grille, together with the shutter and radiator assemblies, is mounted in the front housing. The grille serves as an outlet of air used to cool the radiator.

3-4. REPAIR.

NOTE

Remove grille for repair or replacement only if required as result of inspection. Refer to Operator and Organizational Maintenance Manual.

a. Removal. Refer to Operator and Organizational Maintenance Manual and remove radiator grille.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

b. Cleaning. Clean grille with cleaning solvent (P-D-680, Type II) and dry thoroughly.

c. Repair.

(1) Straighten bent horizontal and vertical crossmembers.

WARNING

Paint is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

(2) Scrape off damaged paint. Blend in edges, prime, and paint (olive drab, per MIL-T-704, Type A, semi-gloss, No. X24087) damaged area.

d. Installation. Refer to Operator and Organizational Maintenance Manual and install radiator grille.

Section III. MAINTENANCE OF TOOL BOX ASSEMBLY

3-5. GENERAL. The tool box assembly is mounted at the skid base below the air intake louver assembly. It serves as storage area for tools required to service or maintain the generator set.

3-6. REPAIR.

a. Removal. Refer to Operator and Organizational Maintenance Manual and remove tool box.

NOTE

Remove and disassemble tool box only if required as result of inspection. Refer to Operator and Organizational Maintenance Manual.

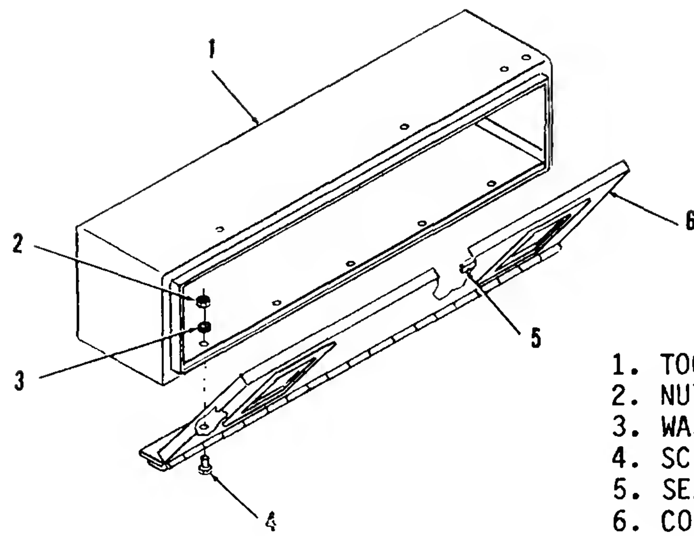
b. Disassembly. Refer to figure 3-1 and disassemble tool box as follows:

(1) Remove nuts (2), washers (3), and screws (4) and separate cover assembly (6) from tool box (1).

(2) Remove seal (5) if damaged or deteriorated.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.



1. TOOL BOX
2. NUT
3. WASHER
4. SCREW
5. SEAL
6. COVER

Figure 3-1. Tool Box Assembly

c. Cleaning.

(1) Clean metal parts with cleaning solvent (P-D-680, Type II) and dry thoroughly.

(2) Clean seal with clean lint-free cloth.

d. Repair.

(1) Straighten bent or distorted parts.

WARNING

Welding operations produce heat, highly toxic fumes, injurious radiation, metal slag, and airborne particles. Welding goggles, the proper tinted lenses, apron, or jacket, and welder's boots are required.

(2) Weld cracks.

(3) Replace damaged or deteriorated seal.

WARNING

Paint is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

(4) Scrape damaged paint. Blend in edges, prime, and paint (olive drap, per MIL-T-704, Type A, semi-gloss, No. X24087) damaged area.

e. Reassembly. Install cover (6) on box (1) and secure with screws (4), washers (3), and nuts (2).

f. Installation. Refer to Operator and Organizational Maintenance Manual and install tool box.

Section IV. MAINTENANCE OF AIR INTAKE LOUVER ASSEMBLY

3-7. GENERAL. The air intake louver assembly is mounted in the rear end of the generator set. The louver assembly serves as coolant air inlet for the generator set.

3-8 REPAIR.

NOTE

Remove air intake louver assembly only if required as result of inspection. Refer to Operator and Organizational Maintenance Manual.

a. Removal. Remove air intake louver assemblies in accordance with procedures in the Operator and Organizational Maintenance Manual.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

CAUTION

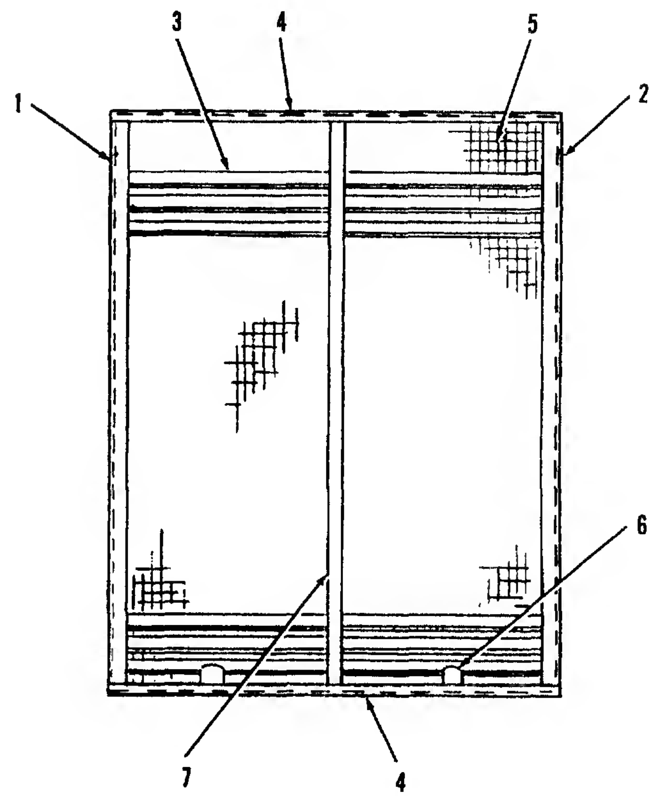
Exercise care when cleaning screen.

b. Cleaning. Clean with cleaning solvent, P-D-680, Type II, and dry thoroughly.

c. Repair. Refer to figure 3-2.

(1) Straighten bent slats (3).

(2) Replace damaged screen (5), ends (4), sides (1 and 2), slats (3), and support slat (7).



1. LEFT SIDE
2. RIGHT SIDE
3. SLAT
4. TOP AND BOTTOM END
5. SCREEN
6. DOOR ROD BRACKET
7. SLAT SUPPORT

Figure 3-2. Air Intake Louver Assembly

WARNING

Welding operations produce heat, high toxic fumes, injurious radiation, metal slag and airborne particles. Welding goggles, the proper tinted lenses, apron or jacket, and welder's boots are required.

(3) Weld defective joints and cracks.

WARNING

Paint is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

(4) Scrape damaged paint. Blend in edges, prime, and paint (olive drab, per MIL-T-704, Type A, semi-gloss, No. X24087) damaged area.

d. Installation. Refer to Operator and Organizational Maintenance Manual and install air intake louver assembly.

Section V. MAINTENANCE OF HINGES AND LATCHES

3-9. GENERAL. Generator access doors are mounted to the frames by hinges. The doors are also equipped and secured with paddle-type latches.

3-10. REPLACEMENT OF HINGES.

a. Remove screws (2, figure 3-3) and nuts (3) that secure top part of hinge (1) to frame.

b. Remove access door.

c. Remove hinge pin and separate upper from lower parts of hinge.

d. Unsolder lower hinge from door.

WARNING

Welding operations produce heat, highly toxic fumes, injurious radiation, metal slag, and airborne particles. Welding goggles, the proper tinted lenses, apron, or jacket, and welder's boots are required.

e. Spot weld lower hinge on access door.

f. Mate upper hinge with lower hinge and insert hinge pin. Peen hinge pin on both ends.

g. Mount access door on frame and secure upper hinge with screws (2) and nuts (3).

3-11. REPLACEMENT OF LATCHES.

a. Remove defective latch (4, figure 3-3) from access door.

WARNING

Welding operations produce heat, high toxic fumes, injurious radiation, metal slag, and airborne particles. Welding goggles, the proper tinted lenses, apron or jacket, and welder's boots are required.

b. Spot weld new latch (4) on door.

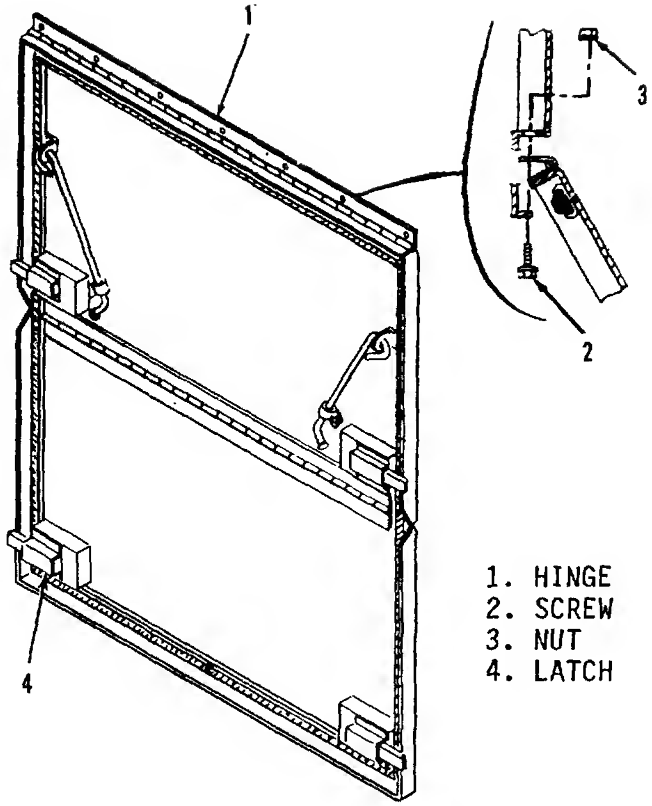


Figure 3-3. Hinges and Latches (Typical)

CHAPTER 4

MAINTENANCE OF DC ELECTRICAL AND CONTROL SYSTEM

Section I. MAINTENANCE OF BATTERY CHARGING ALTERNATOR

4-1. GENERAL. The alternator is a 24 V dc, negative ground system incorporating a voltage regulator and voltage protector. It is driven by the fan pulley via the alternator drive belt. The alternator provides power for charging the batteries and operation of direct current components of the generator set. The following paragraphs provide repair and overhaul instructions for the battery charging alternator. Disassemble the alternator only to the extent required for repair. If the alternator is being overhauled, it must be completely disassembled.

4-2. ON-EQUIPMENT TESTING. Refer to the Operator and Organizational Maintenance Manual for on-equipment testing of the battery charging alternator.

4-3. REMOVAL. Refer to the Operator and Organizational Maintenance Manual and remove the battery charging alternator.

4-4. DISASSEMBLY. To disassemble the alternator, refer to figure 4-1 and 4-2 and proceed as follows:

a. Remove three screws (2) which secure cover and connector assembly (8) to housing (10).

b. Tag and disconnect leads from cover and connector assembly (8) and circuit protector (5).

c. Remove cover and connector assembly (8).

d. Remove eight screws (9) which secure housing (10) to front housing (41) and remove housing (10).

e. Remove two nuts (11), two washers (12), two spacers (13) and remove isolation diode assembly (14).

f. Remove three screws (15), tag and disconnect leads from regulator (16), and remove regulator.

g. Remove two screws (18) and remove cover (19) and brush assembly (20).

h. Remove four bolts (23) and nuts (24) to free rear housing (25). While gently rapping with rawhide hammer, work rear housing (25) free.

CAUTION

Because it may damage stator windings, do not use sharp tools between front and rear housings:

i. Remove diode assemblies (28 and 31) and place spacers (26 and 29) and washers (27 and 30) over threaded studs of diode assemblies.

CAUTION

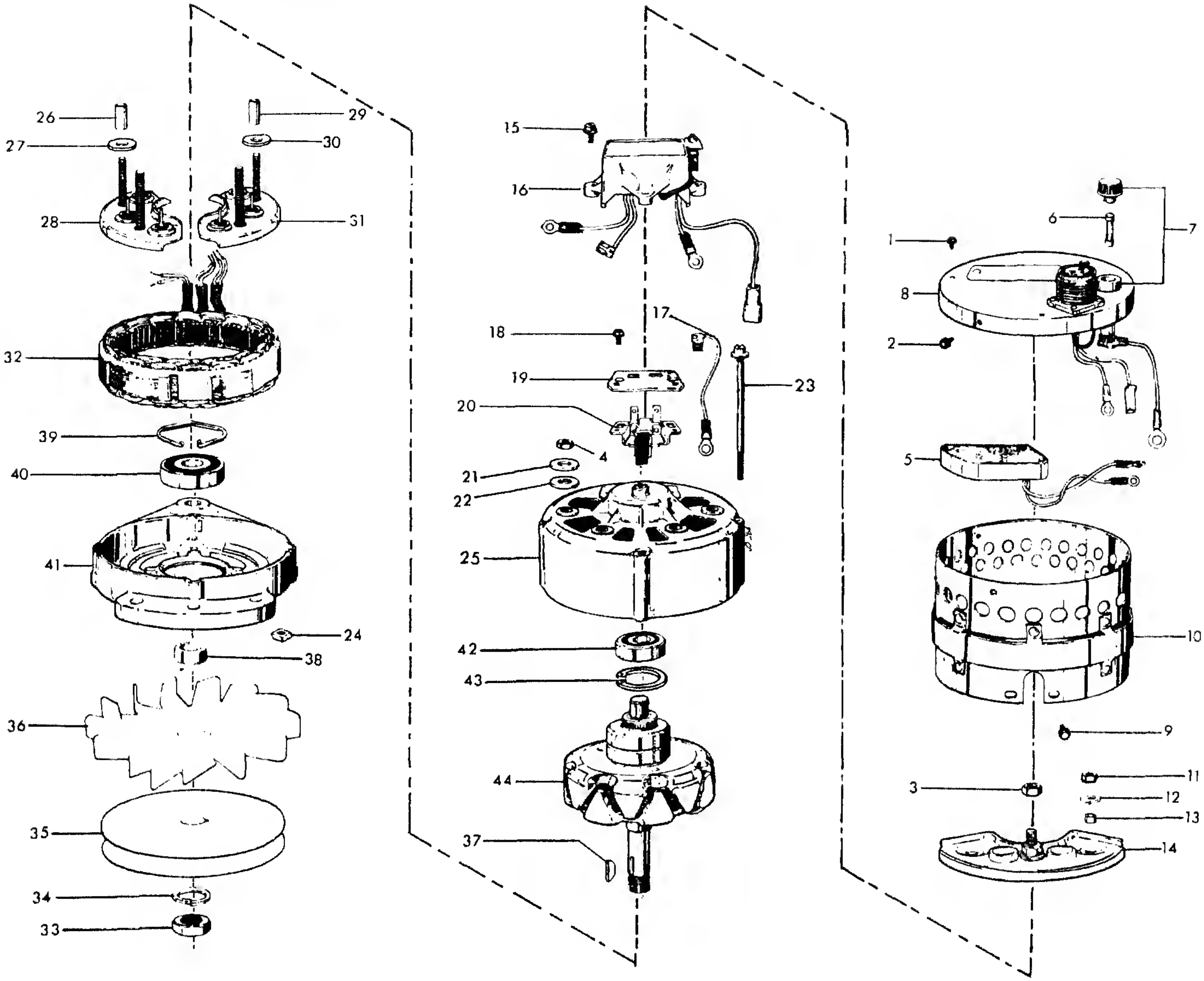
To prevent possible damage to rectifier diodes when unsoldering, grasp diode connections with long nose pliers or other heat sink device.

j. As required, unsolder leads from stator (32) going to diode assemblies (28 and 31) and remove diode assemblies.

k. Remove nut (33) and washer (34) from end of rotor assembly (44) by locking nut (33) in bench vise and turning rotor assembly (44) by hand to free nut (33).

l. Remove pulley (35) and fan (36) from end of rotor assembly (44).

m. Slip woodruff key (37) and spacer(38) off end of rotor assembly(44).



1. SCREW
2. SCREW
3. NUT
4. NUT
5. CIRCUIT PROTECTOR
6. FUSE
7. FUSEHOLDER
8. COVER AND CONNECTOR ASSY
9. SCREW
10. HOUSING
11. NUT
12. WASHER
13. SPACER
14. ISOLATION DIODE ASSY
15. SCREW
16. REGULATOR
17. ELECTRICAL LEAD
18. SCREW
19. COVER
20. BRUSH ASSY
21. WASHER
22. WASHER
23. BOLT
24. NUT
25. HOUSING
26. SPACER
27. WASHER
28. DIODE ASSY
29. SPACER
30. WASHER
31. DIODE ASSY
32. STATOR
33. NUT
34. WASHER
35. PULLEY
36. FAN
37. WOODRUFF KEY
38. SPACER
39. RETAINING RING
40. BEARING
41. FRONT HOUSING
42. BEARING
43. RETAINING RING
44. ROTOR ASSY

Figure 4-1. Alternator Assembly G2, Exploded View

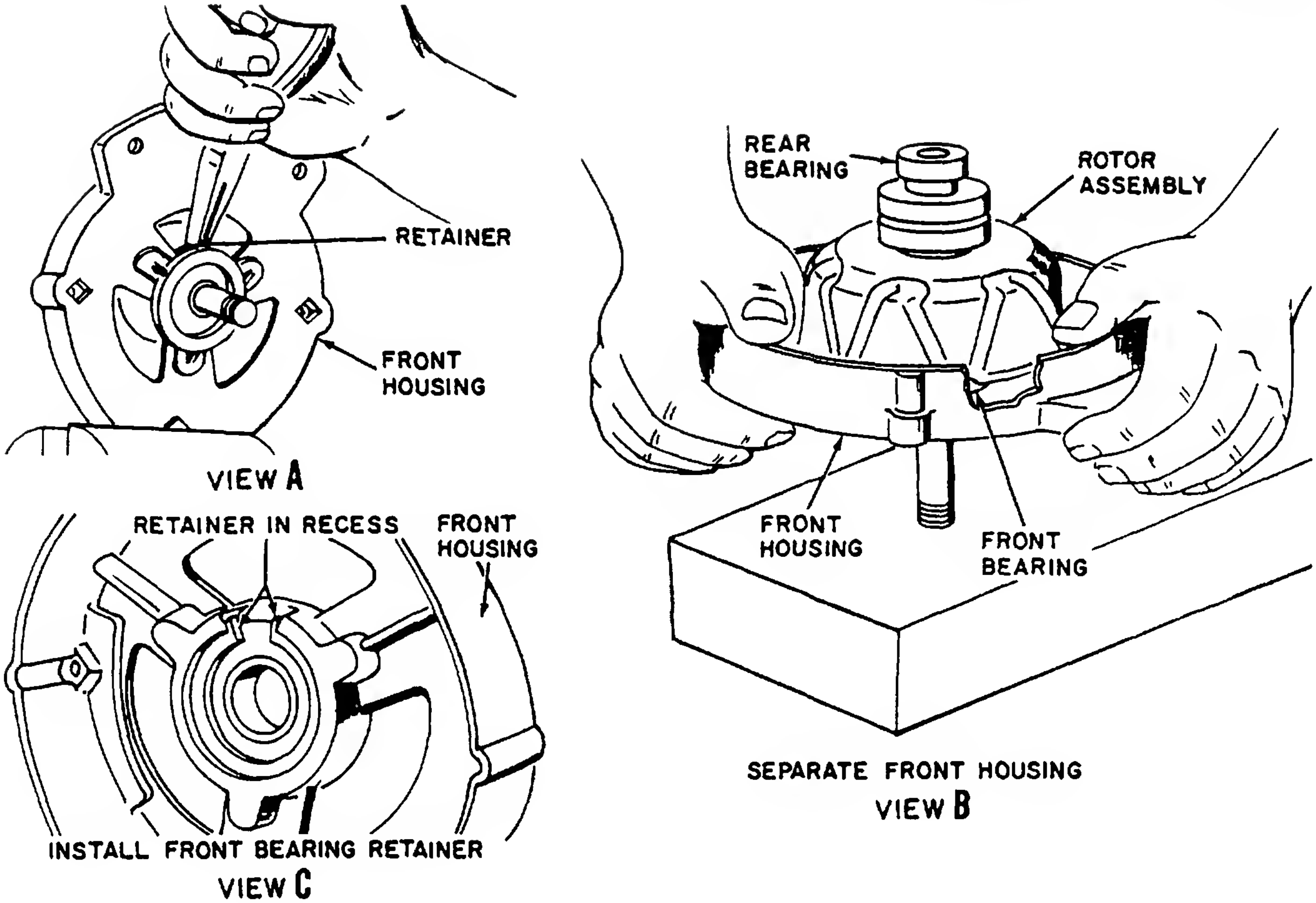


Figure 4-2. Alternator Assembly G2, Bearing Removal and Installation

n. Refer to figure 4-1, remove retaining rings (39 and 43, figure 4-1) and using a puller, remove bearings (40 and 42).

4-5. CLEANING. To clean alternator parts, proceed as follows:

NOTE

Do not immerse alternator assembly in cleaning solvent of any kind. Do not clean isolation diodes (14) with cleaning solvent. The diodes are coated with a special corrosion resistant paint.

WARNING

Cleaning solvent trichloroethane (Tri-ethane) 1.1.1 (MIL-T-8153A) is flammable and toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory tract protection is required.

a. Clean parts with a soft bristle brush moistened with tri-ethane 1.1.1 (MIL-T-81533A).

WARNING

Compressed air used for cleaning or drying can create airborne particles that may enter the eyes. Pressure shall not exceed 30 psi (207 KPa). Wearing of goggles is required.

b. Dry parts with filtered, low-pressure compressed air or a clean lint-free cloth.

4-6. INSPECTION. To inspect alternator parts, proceed as follows:

a. Inspect brush assembly (20, figure 4-1) for excessive wear, replace brush assembly if 3/16 of inch (4.76 mm) or less extends beyond bottom of holder.

b. Check brush assembly (20) spring tension with suitable spring scale. Spring tension should be 4 to 6 ounces (112 to 168 grams).

c. Test rectifier diode in heat sinks connecting one of multimeter leads to the heat sink and the other multimeter lead to the diode stem, and note the reading. Then reverse the multimeter lead connections, and note the reading. If both readings are very low, or if both readings are very high, the diode is defective. A good diode will give one low reading and one high reading (at least 100 times the low reading).

d. Test isolation diode assembly (14) by connecting one of the multimeter test leads to the output terminal stud of the diode, the other to the exposed metal area on heat sink, and note reading. Then reverse the lead connections and note reading. If both readings are very low, or if both readings are very high, the diode is defective.

e. Test stator assembly (32) for grounds and opens as follows:

NOTE

These tests may be made with the leads connected to the diodes provided they are in good condition. Scrape insulation from the leads to ensure good contact with the test probes.

f. Test rotor assembly (44) for grounds between slip ring and shaft, using a multimeter. An open circuit from either slip ring to shaft is a correct condition.

g. Perform resistance check on rotor assembly (44) windings using a multimeter; resistance should be between 11 to 14 ohms.

h. Test voltage regulator (16) by connecting multimeter leads to regulator leads as follows (see figure 4-3):

(1) Connect the multimeter (set to lowest resistance range) to two pairs of stator leads; if reading is very high (over 10 ohms) the stator winding is open.

(2) To test the stator for grounds, connect the multimeter from any stator lead to the ground screw or the shell, and note the reading. If reading is very low, the stator is shorted to ground (defective).

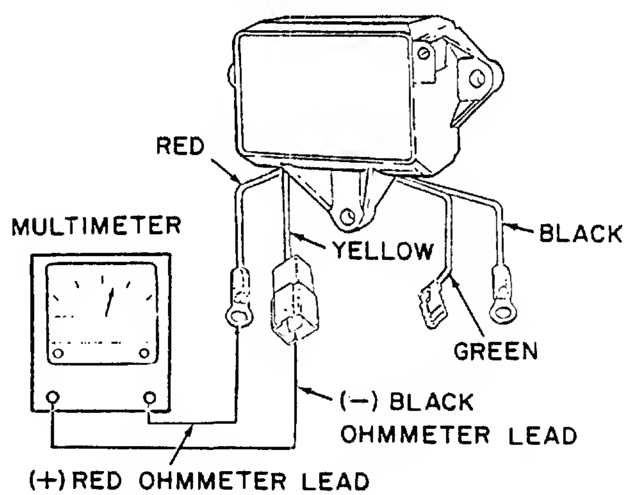


Figure 4-3. Voltage Regulator Excitation Circuit Test

(1) Connect multimeter lead (+) to regulator yellow lead and multimeter lead (-) to regulator red lead; multimeter should indicate between 300 to 350 ohms.

(2) Connect multimeter lead (+) to regulator red lead and multimeter lead (-) to regulator yellow lead; multimeter should indicate an open circuit.

(3) If above readings are not obtained, replace regulator.

i. Inspect fan (36, figure 4-1) for cracked or broken fins. Check fan bore for wear.

j. Inspect pulley (35) for worn drive surfaces and condition of key groove. Check pulley bore for wear.

k. Inspect front bearing cavity for evidence of wear. Check condition of retainer recess.

l. Check slip rings for pitting, roughness, or burned spots. If surface is worn beyond repair, replace entire rotor assembly (44).

m. Inspect rotor shaft for key slot wear, worn bearing surfaces, scuff marks on pole fingers, and condition of threads on pulley nut.

n. Inspect bearings (40 and 42) for scored, pitted, scratched, cracked, or chipped races.

4-7. REPAIR AND OVERHAUL. To repair or overhaul the alternator, proceed as follows:

a. Disassemble the alternator as described in paragraph 4-4.

b. Clean the disassembled parts of the alternator as described in paragraph 4-5.

c. Inspect the disassembled parts of the alternator as described in paragraph 4-6.

CAUTION

Do not attempt to turn slip ring in a lathe.

d. Slip rings may be reconditioned by cleaning contacting surfaces with a fine crocus cloth. Carefully wipe dust and residue away after cleaning.

e. Repair minor thread damage on rotor shaft using a suitable thread chaser.

f. Reassemble the various alternator parts as described in paragraph 4-8.

g. Test and adjust the reassembled alternator as described in paragraph 4-9.

4-8. REASSEMBLY. To reassemble alternator, refer to figure 4-1 and 4-2 and proceed as follows:

NOTE

Refer to schematic wiring diagram figure 4-4 when connecting electrical leads.

NOTE

When installing rear and front bearings (40 and 42) on shaft, use hollow sleeve the same diameter of inner races and press bearings on rotor assembly shaft (44).

a. Using an arbor press, install bearings (40 and 42) in front and rear housings (25 and 41), respectively.

b. Install retaining rings (39 and 43) to secure bearings (40 and 42) in place.

c. Place longer end of rotor assembly (44) shaft through front housing (41).

d. Place spacer (38) over longer end of shaft.

e. Place woodruff key (37) into mechanical keyway in longer end of shaft.

f. Align slots in fan (36) and pulley (35) with woodruff key and press over end of shaft.

g. After placing washer (34) over end of shaft, screw (finger tight) nut (33) onto threaded end of shaft.

h. To prevent rotor assembly (44) from turning when tightening nut (33), wrap an oversize belt around pulley and clamp pulley in vise. Tighten nut (33)

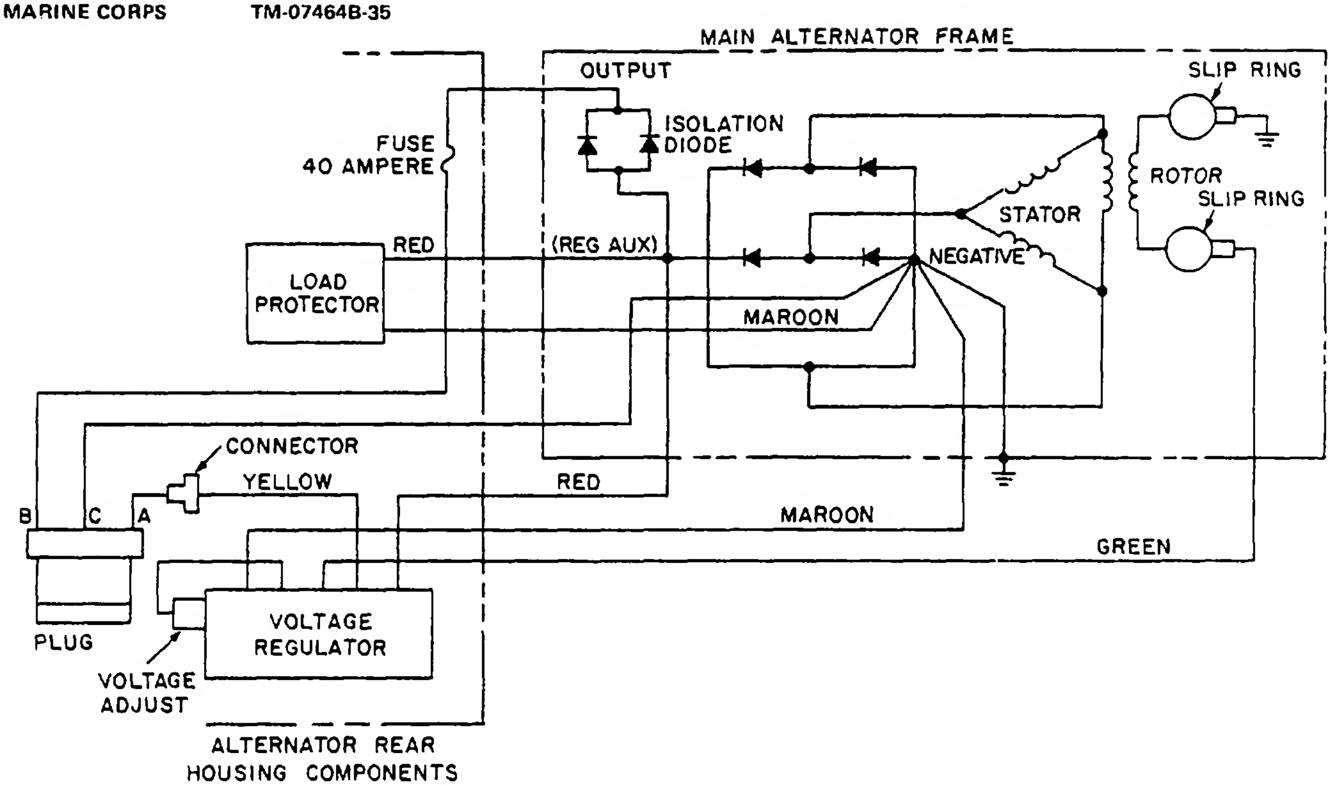


Figure 4-4. Alternator G2, Schematic and Wiring Diagram (Sheet 1 of 2)

to between 35 and 50 foot-pounds torque (47 to 68 Newton-meters).

i. After placing washers (27 and 30) and spacers (26 and 29) over threaded studs of diode assemblies (28 and 31), install stator (32) and diode assemblies (28 and 31) in rear housing (25).

j. Reconnect stator leads as directed by tagging done during disassembly.

CAUTION

To prevent heat damage to rectifier diodes when soldering, use heat sink between soldering iron and diode.

k. Secure items of step i in place with washers (21 and 22) and nuts (4).

l. Place rear housing (25) over front housing (41) while observing locating marks made during disassembly.

m. After ensuring that rotor assembly (44) turns freely, secure front and rear housings in place with bolts (23) and nuts (24). Place terminal of electrical lead (17) over one of bolts (23).

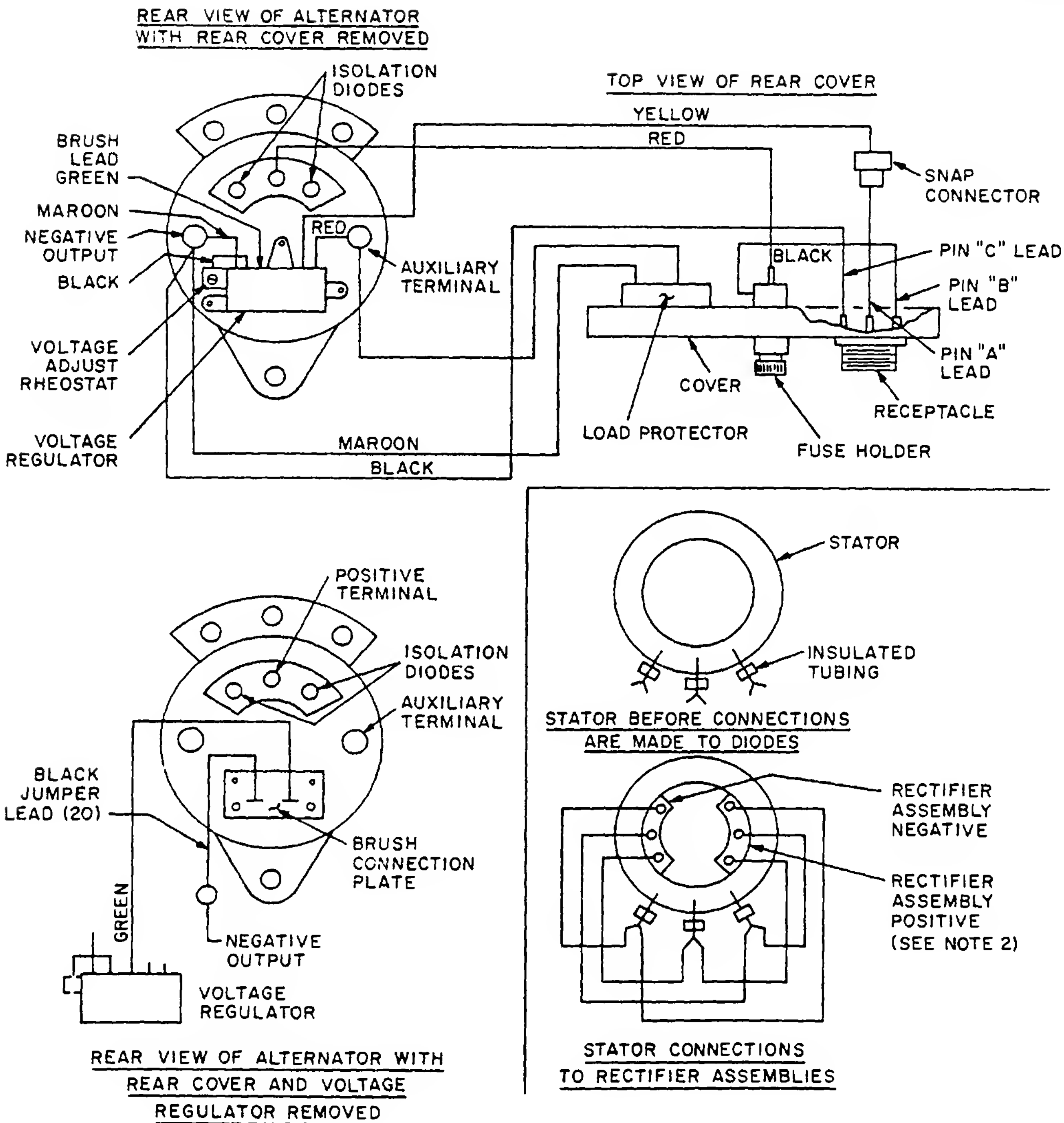
n. Mount brush assembly (20) over rear housing (25) and secure in place with cover (19) and screws (18).

o. Using screws (15), secure regulator (16) in place on rear housing (25). Connect leads from regulator as indicated by tagging done during disassembly.

p. Secure isolation diode assembly (14) over threaded studs projecting from rear housing (25) with spacers (13), washers (12), and nuts(11)

q. Position housing (10) over alternator and secure in place with screws (9).

r. Connect leads from circuit protector (5) and connector (part of cover and connector assembly) as indicated by tagging done during disassembly.



NOTE:

1. THESE TWO LEADS MAY BE CONNECTED TO ANY DIODE ON A RECTIFIER ASSEMBLY PROVIDING ONE DIODE IS ON THE POSITIVE HEATSINK AND THE OTHER DIODE IS ON THE NEGATIVE HEATSINK. THE SAME APPLIES TO THE OTHER TWO SETS OF LEADS.

2. POSITIVE RECTIFIER ASSEMBLY CAN BE IDENTIFIED BY RED LETTERING ON UNDERSIDE OF THE THREE DIODES.

Figure 4-4. Alternator G2, Schematic and Wiring Diagram (Sheet 2 of 2)

s. Using screws (2), secure cover and connector assembly (8) in place over end of housing (10).

4-9. TEST AND ADJUSTMENT. To test and adjust alternator, proceed as follows:

a. Voltage Regulator Setting Test.

CAUTION

Alternator must be driven in direction of arrow on rear cover and connector assembly (8, figure 4-1).

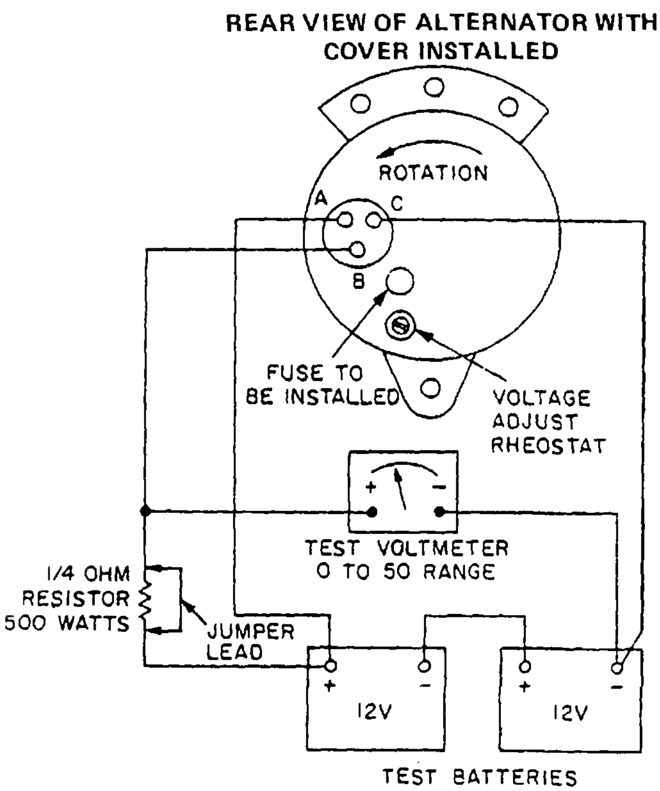


Figure 4-5. Voltage Regulator, Setting Test

(1) Equipment required.

(a) Variable speed drive (2000 to 3000 rpm).

(b) Resistor (1/4 ohm, 500 watt).

(c) DC voltmeter (0 to 50 volt scale).

(d) Two 12-volt batteries.

(e) Jumper 12 inches (300 mm) long, No. 8 wire with two alligator clips.

(2) Connect circuit as shown in figure 4-5.

(3) Connect alternator to variable speed drive by means of a suitable belt and pulley combination.

(4) Run alternator up to a speed between 2000 to 3000 rpm. Connect jumper wire across 1/4 ohm resistor. Run alternator under these conditions for a warmup period of at least 10 minutes.

(5) Remove jumper from across 1/4 ohm resistor and record voltage reading. Nominal voltage should be 28 +3 volts at 75°F (23.6°C) ambient. If nominal voltage is not indicated, adjust voltage adjust rheostat on voltage regulator (16, figure 4-1) which is accessible through rear cover (8) of alternator. Increase voltage by rotating rheostat in a clockwise direction.

(6) If nominal voltage can not be obtained, stop alternator test. Replace voltage regulator and repeat test.

b. Alternator Output Test.

(1) Equipment required in addition to equipment listed in step a.

(a) Carbon pile (0 to 600 ampere load capacity).

(b) Ammeter (0 to 50 amperes).

NOTE

Jumper lead and 1/4 ohm resistor are not used in this test.

(2) Connect circuit as shown in figure 4-6.

CAUTION

Alternator must be driven in direction of arrow (shown on rear cover and connector assembly (8, figure 4-1).

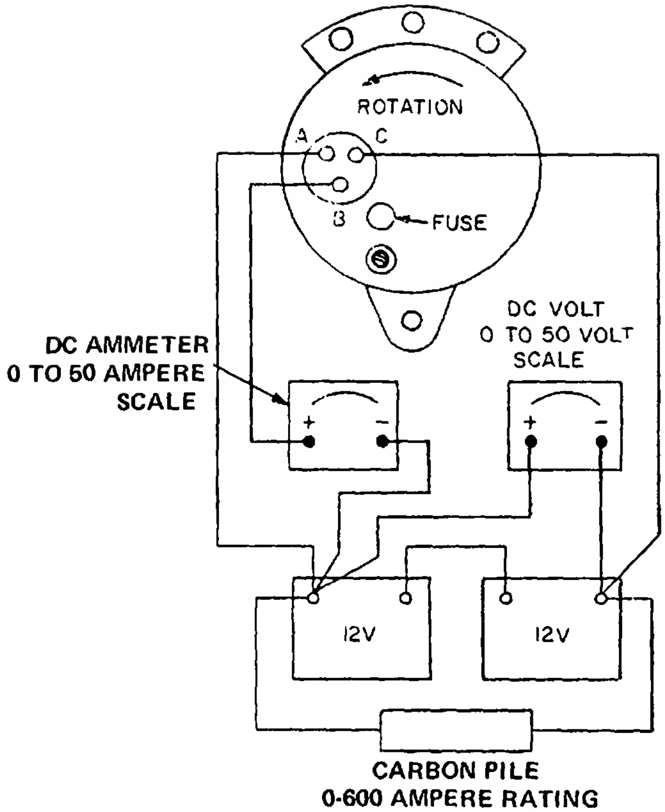


Figure 4-6. Alternator G2, Output Test

NOTE

Make sure drive belt has a midway deflection of 9/16 to 13/16 of an inch (14.3 to 20.6 mm).

(3) Run alternator up to a speed of approximately 1500 rpm. Slowly adjust carbon pile until test ammeter indicates a 10-ampere charging current. Allow alternator to run at this speed and load for at least 5 minutes to stabilize component temperatures.

(4) Increase variable drive speed to 2500 rpm. Increase carbon pile load on battery causing alternator to deliver its maximum current capacity indicated on test ammeter.

(5) Record maximum current obtained. Record voltmeter reading at maximum current condition.

(6) Immediately shut down alternator and disconnect carbon pile from across batteries to prevent discharging batteries.

(7) Nominal current output should be 20 to 25 amperes at 75°F (23.6°C) ambient. This current output of 20 to 25 amperes should be obtained with test voltmeter indicating 26 to 30 volts.

(8) If nominal current of 20 to 25 amperes can not be obtained, check drive belt for proper tension. If drive belt has a midway deflection of 9/16 to 13/16 of an inch (14.3 to 20.6 mm) then disassemble and inspect alternator (refer to paragraph 4-3).

4-10. INSTALLATION. Refer to the Operator and Organizational Maintenance Manual, and install the alternator.

Section II. MAINTENANCE OF SPEED SWITCH S9 AND MAGNETIC PICKUP

4-11. GENERAL. Overspeed switch S9 operates in conjunction with a magnetic pickup mounted in close proximity to the flywheel ring gear. As the teeth of this ring gear move past the magnetic pickup, pulses are induced into the pickup at a rate proportional to engine speed. The strength of these pulses, however, is a function of the gap between the end of the pickup and the outer diameter of the flywheel (ring gear). The setting of this gap is described in paragraph 4-12.

4-12. ALIGNMENT. To align or set the magnetic pickup with reference to the flywheel ring gear, proceed as follows:

a. Shut down engine.

b. Remove magnetic pickup (mounted on flywheel housing) at right side of engine.

CAUTION

Failure to center gear tooth will damage magnetic pickup.

c. Bar engine flywheel so that crest of exposed gear tooth is centered within opening left by magnetic pickup.

d. Install the magnetic pickup in the flywheel housing opening and manually screw in pickup until it bottoms or touches, against crest of gear tooth.

e. Using marking pen, place a small reference mark at some convenient point on magnetic pickup.

f. Screw out magnetic pickup between 95 and 130 degrees (approximately a third of a turn) to obtain the required gap of 0.015 to 0.020 inch (0.381 to 0.508 mm).

NOTE

If generator has been removed, the gap may be measured with a depth micrometer.

g. Taking care not to move setting of magnetic pickup, tighten down on magnetic pickup locknut to secure pickup firmly in place.

4-13. REPAIR. Both the speed switch S9 and the magnetic pickup are nonrepairable items and must be replaced if found to be defective (refer to the Operator and Organizational Maintenance Manual).

4-14. TEST. To test speed switch S9 (figure 4-7), proceed as follows:

a. Shut down generator set.

b. Unscrew four screws from top of speed switch S9 and remove top cover to expose two terminal strips.

c. Connect a frequency counter or meter (capable of measuring from 0 to 100 Hertz) to convenience outlet at front of generator set.

d. Connect a test DC voltmeter (No. 1) across terminals 8 and 9 (starter cutout).

e. Connect a second test DC voltmeter (No. 2) across terminals 8 and 10 (field flash).

f. Start engine and observe test meters as engine picks up speed. When frequency counter or meter reads between 18 and 21 Hz, meters 1 and 2 should switch readings. Initially meter No. 1 should read zero and meter No. 2 should read 24 V dc.

g. Shut down engine and disconnect DC voltmeter No. 1 and connect to terminals 2 and 3.

h. Disconnect DC voltmeter No. 2 and connect to terminals 2 and 4.

i. Start engine and bring up to a frequency counter reading of 60 Hertz. Observe test meters: meter No. 1 should read zero and meter No. 2 should read 24 V dc.

CAUTION

If engine fails to shut down after frequency counter reads 76.0 Hertz, quickly shut down engine.

j. Increase engine speed until engine shuts down: frequency counter should indicate between 74.2 and 75.8 Hertz.

k. Shut down engine, disconnect test equipment, and depress and release OVER SPEED RESET on speed switch.

NOTE

If during step j, above, engine fails to shut down, replace speed switch S9 (refer to Operator and Organizational Maintenance Manual for removal procedures).

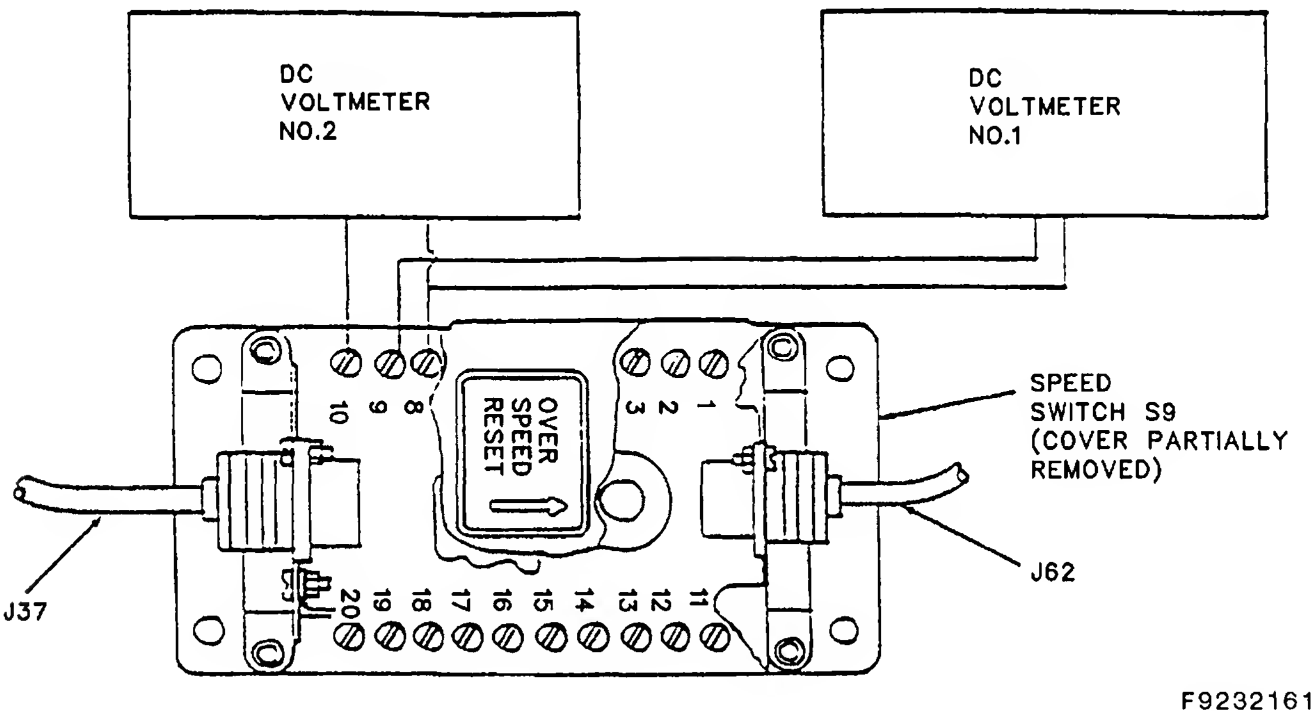


Figure 4-7. Speed Switch S9 and Magnetic Pickup, Test Setup

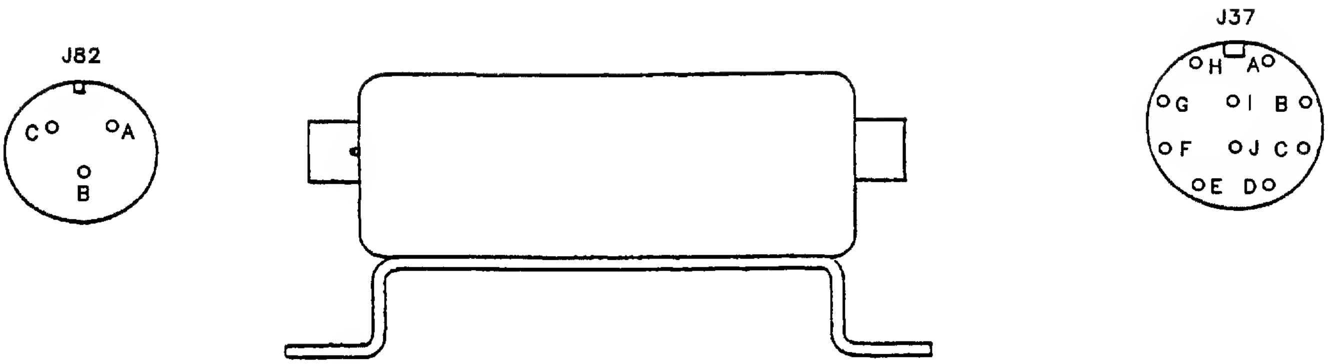
4-14A. Test of alternate speed switch S9. 90-4002 Figure 4-7A, proceed as follows:

a. Connect 24VDC power supply, positive to pins E & G negative to pin I of connector J37 on speed switch.

b. Connect a variable frequency source (0-5000 Hz) to pins A & B of connector J62.

c. Using and ohm meter verify resistance reading across connector J37 per fig. 4-7A.

d. Apply DC power. As variable frequency source is increased, verify resistance reading across J-37 in accordance with fig. 4-7A.



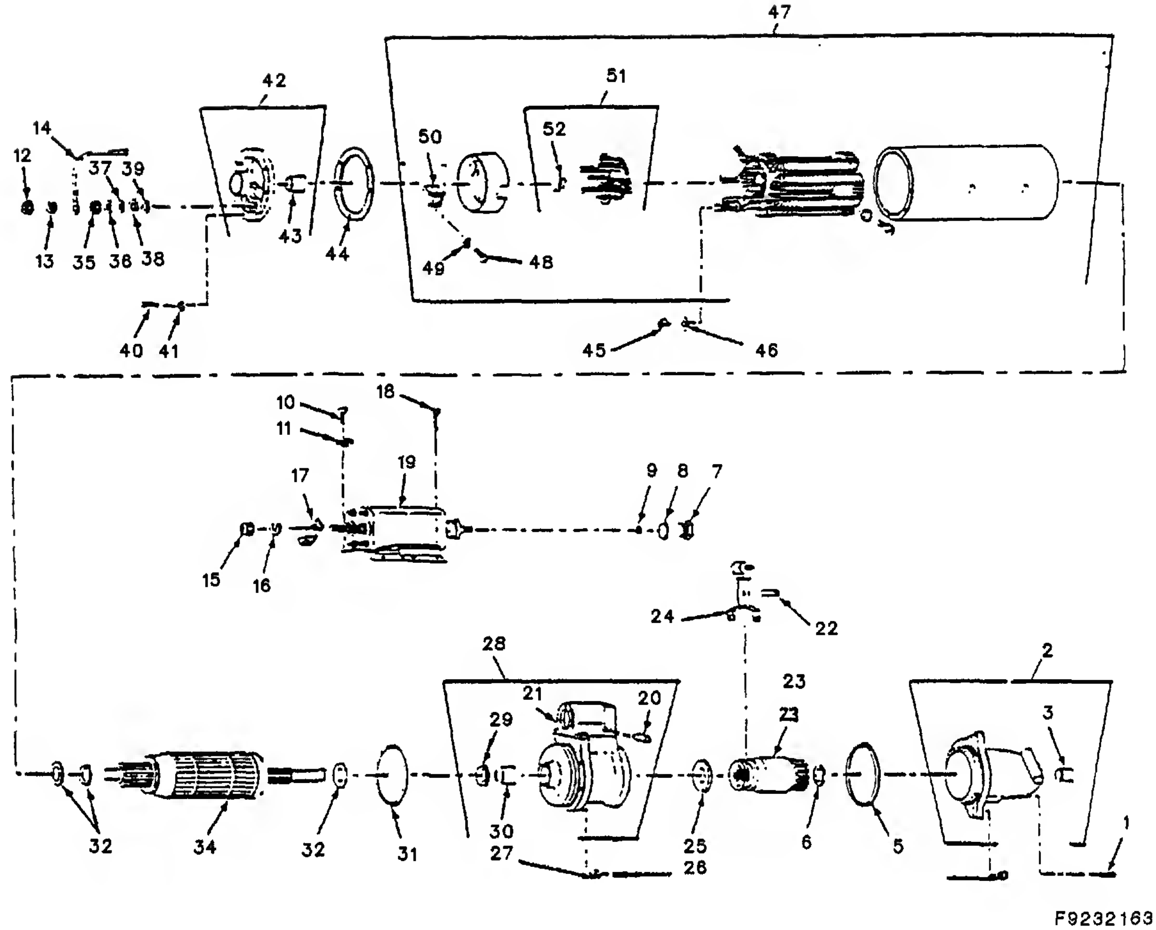
F9232162

FREQUENCY ± 1% HZ	RESISTANCE (OHMS) ACROSS J37				
	A-B	A-C	D-E	F-J	H-G
0	0	∞	∞	∞	0
1290	∞	0	∞	∞	0
2580	∞	0	0	∞	0
4837	∞	0	0	0	∞

Figure 4-7A. Alternate Speed Switch S9, (90-4002) Test Setup.

Section III. MAINTENANCE OF STARTER ASSEMBLY B1

4-15. GENERAL. The starter motor B1 is mounted to the flywheel housing. It consists of a frame and field assembly, armature head assembly, intermediate housing assembly, brush assembly, and a solenoid switch. The starter motor B1 is a heavy-duty type that is completely sealed with gaskets, performed packings and an oil seal. The solenoid is mounted on the outside of the frame with the solenoid plunger and pinion engagement mechanism totally enclosed. The starting motor converts electrical energy from the batteries into mechanical energy to turn the engine over for starting. The following paragraphs provide repair and overhaul instructions for starter motor B1. Disassemble the starter motor B1 only to the extent required for repair. If the starter is being overhauled, it must be completely disassembled.



1. SCREW
2. PINION HOUSING
3. BEARING
4. PLUG
5. PACKING
6. THRUST WASHER
7. PLUG
8. GASKET
9. NUT
10. SCREW
11. CLIP
12. NUT
13. LOCKWASHER
14. LEAD ASSY
15. NUT
16. LOCKWASHER
17. CONNECTOR
18. BOLT
19. SOLENOID SWITCH
20. PIN
21. YOKE COVER
22. PIN
23. STARTER DRIVE
24. YOKE ASSY
25. WASHER
26. SCREW
27. LOCKWASHER
28. INTERMEDIATE HOUSING
29. SEAL
30. BEARING
31. SEAL
32. THRUST WASHER
33. THRUST WASHER
34. ARMATURE
35. NUT
36. LOCKWASHER
37. INSULATING WASHER
38. CAP WASHER
39. WASHER
40. SCREW
41. LOCKWASHER
42. HEAD ASSEMBLY
43. BEARING
44. GASKET
45. BUSHING
46. INSULATING WASHER
47. FRAME AND FIELD ASSY
48. SCREW
49. WASHER
50. BRUSH
51. BRUSH PLATE
52. SPRING

Figure 4-8. Starter Motor B1, Exploded View

4-16. REMOVAL. Refer to the Operator and Organizational Maintenance Manual to remove the starter motor B1.

4-17. DISASSEMBLY. To disassembly starter motor B1, refer to figure 4-8 and proceed as follows:

a. Remove six screws (1) and separate pinion housing (2) and bearing (3) from intermediate housing (28). Before separating pinion housing (2) from intermediate housing (28), scribe or center punch locating marks to facilitate reassembly.

b. If required, remove six plugs (4).

c. Remove packing (5) and thrust washer (6).

d. Separate solenoid switch (19) from frame and field assembly (47) by removing four bolts (18).

e. Remove seven screws (26) and lockwashers (27) and separate intermediate housing (28) from frame and field assembly (47).

f. Remove armature (34) along with items 29 through 33.

g. Remove nut (12), lockwasher (13), and lead assembly (14).

h. Remove nut (35), lockwasher (36), insulating washer (37), cap washer (38), and washer (39).

i. Remove seven screws (40), seven lockwashers (41), and separate head assembly (42) from frame and field assembly (47). Scribe or center punch a locating mark prior to separating head assembly (42) and frame and field assembly (47).

j. Using bearing puller, separate bearings (3, 30, and 43) from armature (34).

k. Replace gasket (44).

l. Remove three screws (48) and washers (49) and work insulator cup (part of 47) free.

m. Remove brush plate (51) and spring (52).

4-18. CLEANING. To clean starter motor B1 parts, proceed as follows:

CAUTION

To prevent damage to brushes, do not allow dry cleaning solvent to come in contact with brushes.

a. Clean brushes with a clean, dry cloth only.

WARNING

Cleaning solvent trichloroethane (Tri-ethane) 1.1.1 (MIL-T-81533A) is flammable and toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory tract protection is required.

del ~~b. Clean electrical components with a clean lint-free cloth moistened with cleaning solvent, Tri-ethane 1.1.1 (MIL-T-81533A), and dry thoroughly.~~

del see OS-1

WARNING

~~Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.~~

c. Clean metal parts with a clean cloth moistened with cleaning solvent, P-D-680, Type II, and dry thoroughly.

WARNING

Compressed air used for cleaning or drying can create airborne particles that may enter the eyes. Pressure shall not exceed 30 psi (207 kPa). Wearing of goggles is required.

CAUTION

Do not use emery cloth to clean commutator.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

d. Remove loose particles from armature with compressed air and wipe with a clean lint-free cloth moistened with dry cleaning solvent (P-D-680, Type II). Clean commutator lightly with No. 00 sandpaper and remove all traces of dust using low-pressure compressed air.

4-19. INSPECTION. To inspect starter motor B1 parts, proceed as follows:

a. Refer to table 1-3 and inspect parts for dimensional tolerances.

b. Inspect housings and commutator end head, pinion teeth, and splines for scratches, burrs, nicks, and cracks.

c. Inspect bearings for discoloration, rough spots, score marks, scratches and nicks.

d. Inspect threaded parts for thread damage.

e. Inspect commutator on armature (34, figure 4-8) for rough spots, discoloration, pitting, scoring, and high mica.

f. Inspect armature shaft (34) for pitting, scoring, or excessive wear. Inspect starter drive (23) for broken teeth on pinion. Check to see that starter drive (23) clutch assembly moves on armature shaft (34) to see if splines fit properly.

g. Inspect solenoid switch (19) parts. Check condition of moving core and sealing boot. Check connector (17) and terminal studs to see if they are burned, eroded, or pitted excessively.

h. Using a suitable spring scale, check brush springs (52) tension. Tension should be 50 to 60 ounces (1400 to 1680 grams).

i. (A) Refer to Operator and Organizational Maintenance Manual, Appendix A for Electric Motor and Generator Repair Manual, and check armature and field coils for shorts, open circuits, and grounds. Check armature for shorts using a suitable growler.

4-20. REPAIR AND OVERHAUL. To repair starter motor B1, proceed as follows:

a. (A) Refer to Operator and Organizational Maintenance Manual, Appendix A for Electric Motor and Generator Repair Manual for general repair instructions.

b. Remove minor nicks and burrs from housings, commutator end head, pinion teeth and splines using a suitable hone.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

c. Replace discolored, spotted or scored bearings. Remove minor nicks and scratches from bearings using crocus cloth dipped in cleaning solvent (P-D-680, Type II).

d. Repair minor thread damage using a thread chaser.

NOTE

Armature must be replaced if commutator diameter is not within limits specified in table 1-3 after repair.

e. Repair commutator on armature (34, figure 4-8) by turning it down

using a suitable lathe. Take light cuts until all defects are removed. Remove all burrs by holding No. 00 sandpaper lightly against commutator. Undercut mica to a depth of 1/3 of an inch (0.8 mm) using a suitable mica undercutter.

f. Replace parts that are not within dimensional tolerances specified in table 1-3.

4-21. ASSEMBLY. Refer to figure 4-8 and assemble starter motor B1 as follows:

a. Install coil assembly (part of frame and field assembly (47)) and secure with screws.

b. Mount brush plate assembly (51) and spring (52) over end of coil assembly and secure with screws.

c. Install eight brushes in brush plate (51) and secure with screws (48) and washers (49). Seat brushes as follows:

(1) Install armature (34) in frame and field assembly (47) until armature (34) commutator contacts brushes (50).

(2) Raise brushes (50) until brushes are seated on armature (34) commutator.

(3) Cut a strip of No. 00 sandpaper the width of the armature (34) commutator. Install sandpaper on armature (34) commutator with sand side out by raising brushes (50) and slipping sandpaper between armature (34) commutator and brushes (50). Brushes (50) must lie flat against sandpaper on armature (34) commutator to obtain desired brush (50) seat contour.

(4) Install armature (34) and head assembly (42) on frame field assembly (47).

(5) Carefully rotate armature (34) in a counterclockwise direction three to five revolutions to properly seat brushes (50).

(6) Remove head assembly (42). Lift all brushes (50) and inspect seat contour to determine whether or not sanding operation is satisfactory. A satisfactorily seated brush (50) should show evidence of contact on at least 85 percent of its length and 100 percent of its thickness.

(7) Lift brushes (50) and remove sandpaper from armature (34) commutator.

WARNING

Compressed air used for cleaning or drying can create airborne particles that may enter the eyes. Pressure shall not exceed 30 psig (207 kPa). Wearing of goggles is required.

(8) Remove armature (34) from frame and field assembly (47). Clean armature (34), brushes (50) and frame and field assembly (47). Blow out sanding dust using compressed air.

(9) Coat shaft and splines on armature (34) with grease MIL-G-23827. Install armature (34), see steps (1) and (2), above.

d. When assembling intermediate and pinion housing assemblies (28 and 2), torque hex head screws (1) to 8 foot pounds (10.86 Newton-meters). Make sure locating marks are aligned.

e. After assembly, the insulation on both terminal studs of frame and field assembly (47) should be coated with glyptal sealant. Keep sealant off contact surfaces of terminal studs and nuts.

f. Hold either original or replacement gasket (44) in place while securing head assembly (42) to frame and field assembly (47) with seven screws (40) and seven lockwashers (41). Orient head assembly (42) so that threaded terminal from coil assembly projects through hole in head assembly.

g. Install washer (39), cap washer (38), insulating washer (37), lockwasher (36) over threaded terminal and lock in place with nut (35).

h. Place thrust washers (32 and 33) and seal (29) over armature shaft (34).

i. Using an arbor, press bearing (30) into end of intermediate housing (28). Remove wick from pinion housing (2), intermediate housing (28), and head assembly (42) reservoirs before installing new bearings (3, 30, and 43). After new bearing installation, saturate felt wicks with SAE 10 oil, install wicks in reservoirs and fill with SAE 10 oil.

j. Position seal (31) on end of intermediate housing (28).

NOTE

Lubricate packing (5) and seal (31) with a film of light grease MIL-G-23827 to prevent damage during reassembly.

k. Secure intermediate housing (28) end of frame and field assembly (47) with seven screws (26) and seven lockwashers (27).

l. Place washer (25) over end of armature (34).

NOTE

Lubricate armature (34) bearing surfaces on shaft with SAE 10 oil. Lubricate shaft and splines under starter drive (23) with grease that conforms to Military Specification MIL-G-23827.

m. Place fork of yoke assembly (24) over starter drive and insert both into intermediate housing (28).

n. Insert pin (22) through hole of yoke assembly (24) and secure in place.

o. Position solenoid switch (19) over frame and field assembly (47) and secure in place with four bolts (18).

q. Secure yoke assembly (24) to plunger of solenoid switch (19) with nut (9).

r. Place thrust washer (6) over end of armature shaft.

s. Position original or replacement packing (5) over pinion housing (2) and secure pinion housing in place over frame and field assembly (47) with six screws (1).

4-22. TESTING AND ADJUSTING. To test and adjust starter motor B1, proceed as follows (refer to figures 4-8 and 4-9):

a. <u>Equipment.</u>

(1) Two 12-volt batteries (4 batteries will be required if stall torque is to be performed).

(2) DC voltmeter (0 to 50 volts).

(3) DC ammeter (0 to 500 amperes).

(4) Carbon pile (0 to 600 amperes capacity).

(5) Spring scale (0 to 50 pounds, 0 to 25 kg).

(6) Pony brake arm 12 inches (304 mm) long.

(7) Hand held tachometer (0 to 10,000 rpm).

<u>CAUTION</u>

Never operate the starting motor more than 30 seconds at a time during test. Allow the motor to cool for at least 2 minutes between each crank cycle.

b. <u>No Load Test.</u>

(1) Connect no load current test setup as shown in view A of figure 4-9.

(2) Adjust carbon pile to obtain a voltage of 22 volts. Current drain should be 90 amperes (maximum) at 7000 rpm.

(3) Apply rubber tip of hand held tachometer to end of shaft in drive housings to read rpm.

(4) If current is too high, check bearing alignment end play. Two or three sharp raps with a rawhide hammer while cranking will often help align bearings and free armature.

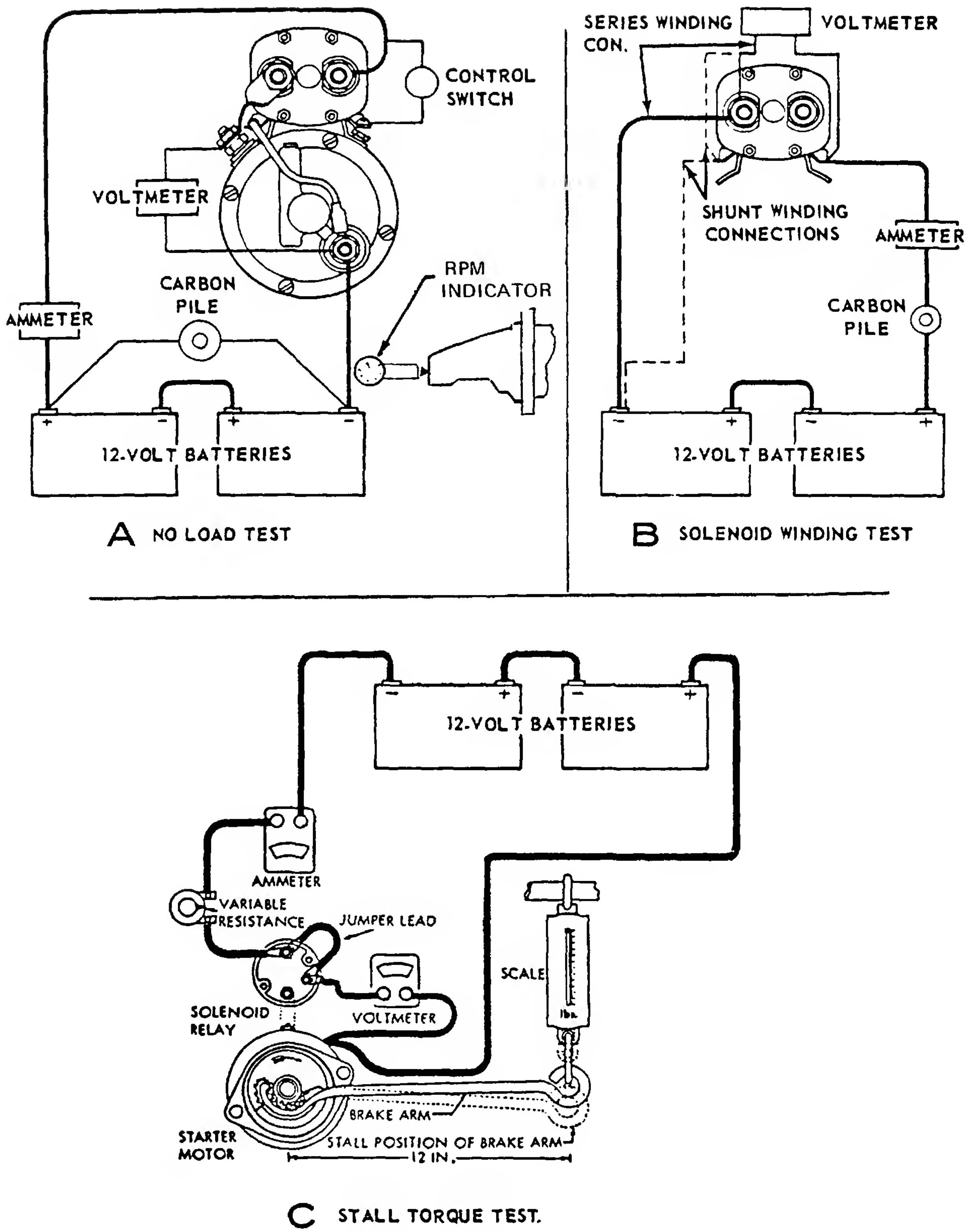


Figure 4-9. Starter Motor B1, Test Setup

c. Solenoid Winding Test.

(1) Make solenoid winding test setup as shown in view B of figure 4-9.

(2) Test current draw and make ground and open test on winding. Series winding values at 70°F (21°C) should be 23.2 to 26.6 amperes at 12.9 volts. Shunt winding values at 70°F (21°C) should be 4.1 to 4.8 amperes at 12.9 volts. Adjust carbon pile to obtain 12.9 volts.

d. Stall Torque Test.

(1) Make stall torque test setup as shown in view C of figure 4-9.

(2) The solenoid winding shall be activated with a separate battery.

(3) Stall torque test values should be 4.9 volts, 400 amperes (maximum), and 22.0 foot-pounds (30 Newton-meters). Adjust variable resistance to obtain 4.9 volts at 400 amperes.

(4) If stall torque values are too low, check armature, brush spring tension, contact area, and switch contact. If these components are not at fault, replace entire starting motor.

e. Armature End Play Adjustment. Adjust end play to 0.005 to 0.030 inches (0.127 to 0.762 mm) by adding or removing thrust washers on commutator end of armature shaft.

f. Pinion Position Adjustment (see figure 4-10). This adjustment assures correct relation between solenoid and indexing drive assembly. If adjustment is not correct, damage may result to drive gear and/or flywheel ring gear.

(1) Connect a 12-volt battery as shown in view A of figure 4-10.

(2) Momentarily touch the jumper lead between terminal stud of solenoid and terminal stud in commutator and head. This will shift solenoid and drive assembly into cranking position until battery is disconnected.

(3) Push drive assembly toward commutator end of motor to eliminate any slack movement in linkage.

(4) Measure distance between outside edge of drive sleeve and thrust washer as shown in view B of figure 4-10. This distance should be 0.020 to 0.050 inches (0.51 to 1.27 mm). If measurement is not correct, remove plug and washer from shift linkage cover and adjust nut as required to obtain proper measurement. Disconnect battery.

(5) Make test setup as shown in view C of figure 4-10. Leave switch open.

(6) Place an interference block with 0.983 inch (25 mm) side against drive gear as shown in view D of figure 4-10.

CAUTION

Because of the heavy current being passed through solenoid winding, these tests should be made as brief as possible.

(7) Close switch in battery circuit. The 12-volt lamp should not light. Be sure interference block is against drive gear and not against drive sleeve. If lamp does not light, proceed to step (8). If lamp lights, solenoid is defective. Replace solenoid, then repeat test.

(8) If test lamp does not light, open switch and connect a carbon pile and voltmeter into test circuit as shown in view E of figure 4-10.

(9) Place an interference block with 1/2-inch (12.7 mm) side against drive gear. Close switch and be sure interference block is against drive gear and not against drive sleeve.

(10) Adjust carbon pile and observe voltmeter. The test lamp must light before the voltmeter reads 16 volts. If lamp does not light, adjust nut (view B of figure 4-10) until proper setting is obtained.

(11) Reinstall plug and washer in shift linkage cover.

4-23. INSTALLATION. Refer to the Operator and Organizational Maintenance Manual and install starter motor B1.

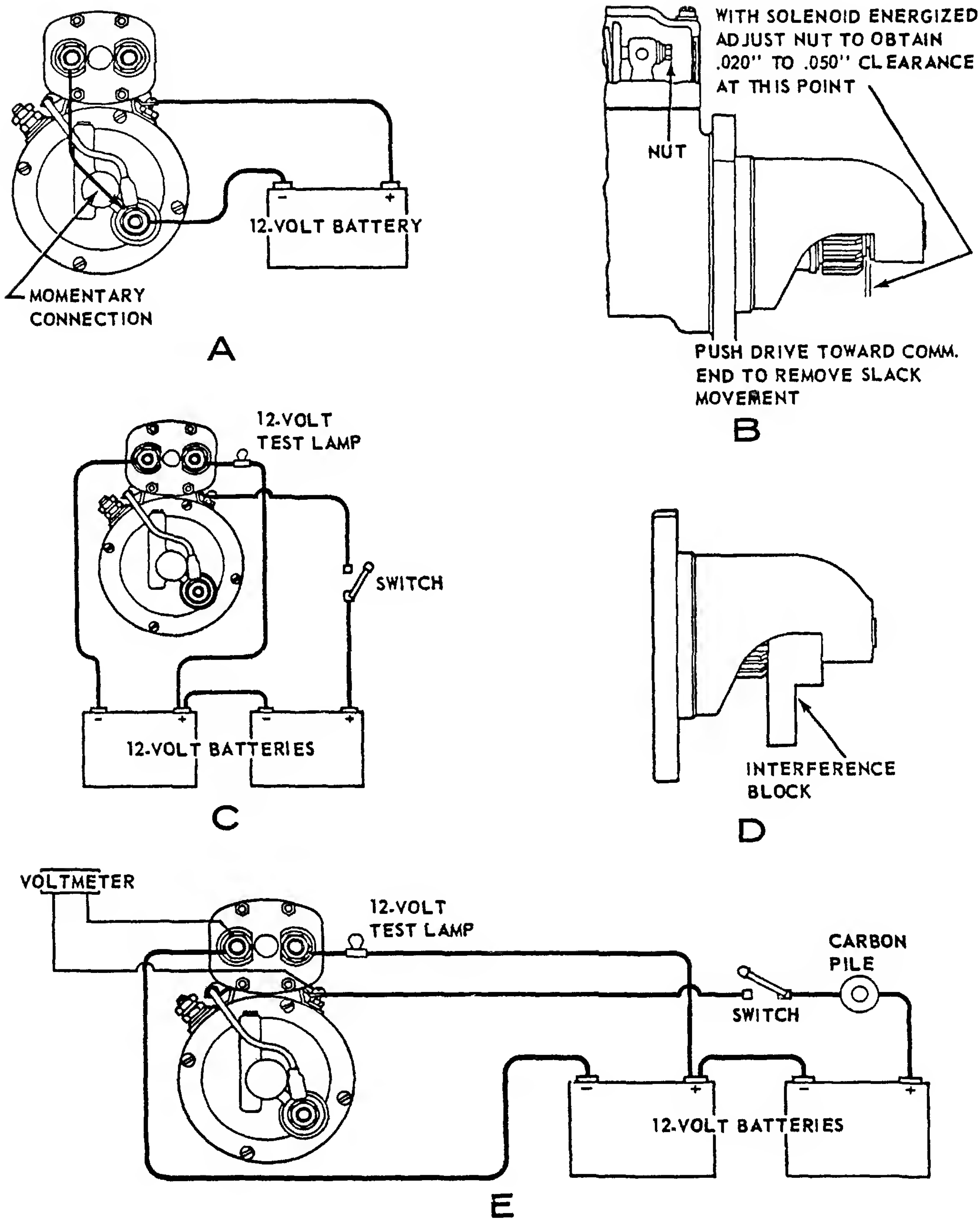


Figure 4-10. Starter Motor B1, Pinion Position, Test Setup

CHAPTER 5

MAINTENANCE OF SET CONTROLS AND INSTRUMENTATION

Section I. MAINTENANCE OF FAULT INDICATOR A9

5-1. GENERAL. When any one of several types of either generator or engine malfunctions occur, a particular light of fault indicator A9 lights. Repair procedures for A9 are provided in this section. (For additional information on A9 refer to the Operator and Organizational Maintenance Manual).

5-2. REPAIR. To repair A9, proceed as follows:

a. Repair or fabricate fault indicator A9 wiring harness in accordance with figure 5-1.

b. Repair or fabricate fault indicator A9 hookup wire in accordance with table 5-1.

c. Replace defective switch, relays, light assemblies, fuse holder, or indicator lenses.

d. Repair circuit board as follows:

(1) Restencil all illegible reference designations:

CAUTION

Prolonged use of soldering equipment could cause damage to components due to excessive heat.

WARNING

Avoid breathing fumes generated by soldering. Eye protection is required. Remove rings and watches while soldering.

(2) Replace all defective components.

(3) Solder replacement components on the circuit boards using solder conforming to Federal Specification QQ-S-571 Sn60.

(4) Solder joints and/or component leads must not project more than 0.094 inch (2.388 mm) beyond surface of board.

(5) After replacement of components on the circuit boards, coat the boards with protective coating, conforming to Military Specification MIL-I-46058, grade S, type PUR, 0.005 inch (0.127 mm) minimum thickness. Air bubbles should be prevented during coating so that legibility of identification or information markings is not impaired. The coating shall be applied so that it anchors the components to the board. Terminals utilized for connection to external circuits shall not be coated.

WARNING

Paint is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

e. Straighten dented or distorted sheet metal parts using proper tools. Blend in repaired area with suitable abrasive paper. Using olive drab, per MIL-T-704, Type A, semi-gloss, No. X24087, prime and touch up damaged painted surfaces.

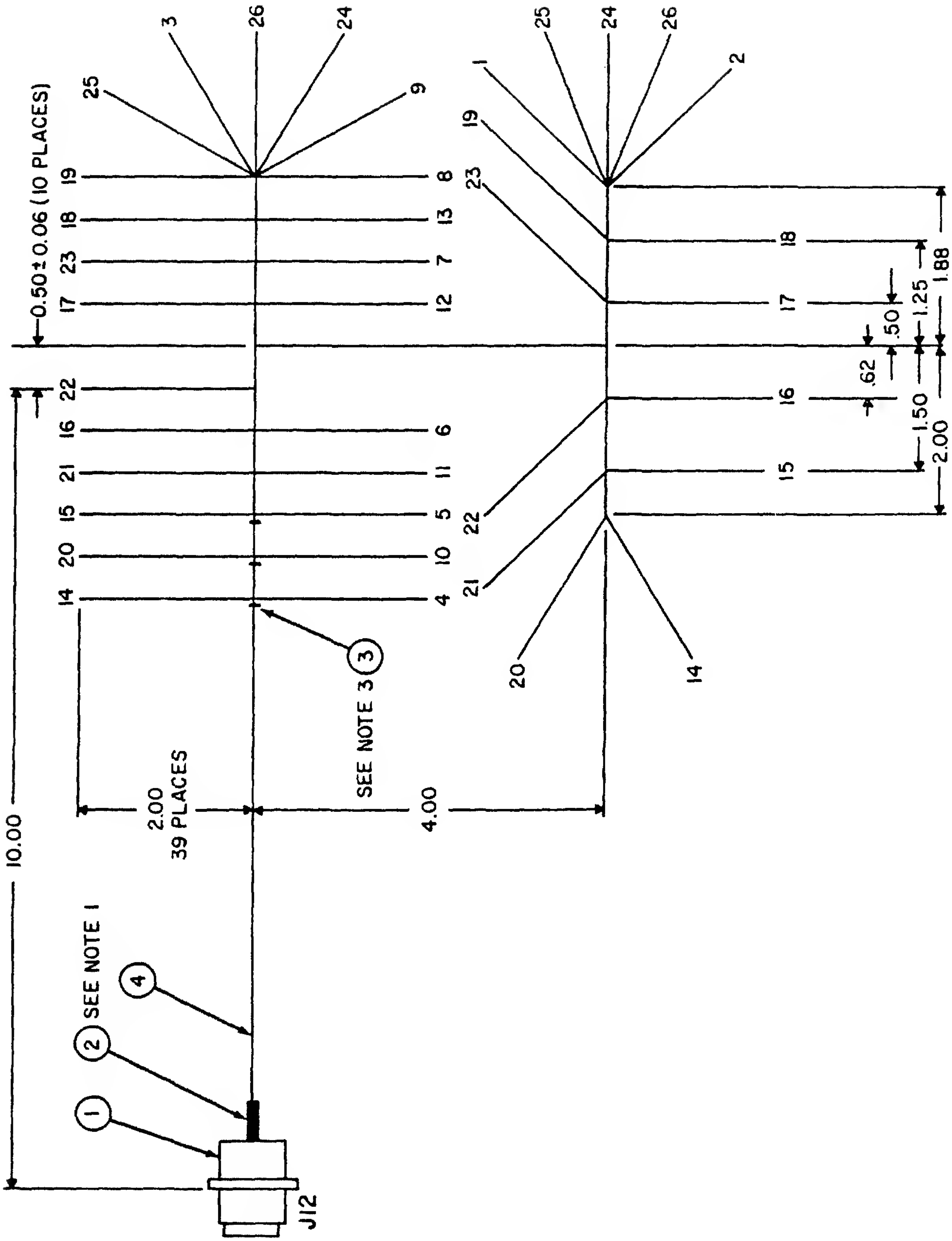


Figure 5-1. Fault Indicator A9, Wiring Harness (Sheet 1 of 2)

WIRE NO.	TERMINATION FROM	FIND NO.	TO	WIRE FIND NO.
1	J12-A	1	XF1	4
2	J12-B	1	S1-2	4
3	J12-C	1	XK1-1	4
4	J12-D	1	TB1-1	4
5	J12-E	1	TB1-3	4
6	J12-F	1	TB1-5	4
7	J12-G	1	TB1-7	4
8	J12-H	1	TB1-9	4
9	J12-1	1	TB1-10	4
10	J12-K	1	TB1-2	4
11	J12-L	1	TB1-4	4
12	J12-M	1	TB1-6	4
13	J12-N	1	TB1-8	4
14	XDS1	-	TB1-21	4
15	XDS2	-	TB1-25	4
16	XDS3	-	TB1-29	4
17	XDS4	-	TB1-33	4
18	XDS5	-	TB1-37	4
19	XDS6	-	TB1-39	4
20	XDS7	-	TB1-23	4
21	XDS8	-	TB1-27	4
22	XDS9	-	TB1-31	4
23	XDS10	-	TB1-35	4
24	S1-6	-	XK1-3	4
25	S1-3	-	TB1-40	4
26	S1-4	-	TB1-50	4

NOTES:

1. AFTER SOLDERING, INSTALL INSULATION. FIND NO. 2, .62 LONG, OVER EACH CONTACT OF CONNECTOR, FIND NO. 1.
2. EACH WIRE NOT TERMINATING AT FIND NO. 1 SHALL BE STRIPPED .25± .06 INCH AND TINNED.
3. INSTALL STRAPS, FIND NO. 3 AT APPROXIMATELY ONE INCH INTERVALS AND AT EACH WIRE BREAKOUT (25 MINIMUM).
4. OPTIONAL WIRING: ALL WIRES MAY BE WHITE INSTEAD OF COLOR CODED.
5. MARK WIRES WITH WIRE NO. 5 (SEE TABLE) AT INTERVALS OF 3 INCHES.

FIND NO.	SYM	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
4	*		TYPE-E-22	AR	WIRE. ELEC. INSULATED HIGH TEMP. 600 V. NO. 22 AWG SIZE (302 IN.)	MIL-W-16878 4	
3	*		MS 17821-1-9	AR	STRAP. CABLE. ADJUSTABLE		SEE NOTE 3
2	*		TYPE-F, FORM Ua, GRADE-a, CLASS I CATEGORY 1	AR	INSULATION. ELECTRICAL	MIL-I-631	
1		B	69-502-7	1	CONNECTOR. RECEPTACLE		

LIST OF MATERIAL

Figure 5-1. Fault Indicator A9, Wiring Harness (Sheet 2 of 2)

Table 5-1. Fault Indicator A9, Hookup Wire Data

COLOR	WIRE	WIRE LENGTH INCHES (MM)	FROM	TO
WHT	27	1-1/2 (38.1)	S1-1	S1-6
WHT	28	2-1/2 (63.5)	S1-6	XDS6
WHT	29	1-1/4 (31.75)	XDS6	XDS10
WHT	30	1-1/4 (31.75)	XDS10	XDS9
WHT	31	1-1/4 (31.75)	XDS9	XDS8
WHT	32	1-1/4 (31.75)	XDS8	XDS7
WHT	33	1-1/4 (31.75)	XDS7	XDS1
WHT	34	1-1/4 (31.75)	XDS1	XDS2
WHT	35	1-1/4 (31.75)	XDS2	XDS3
WHT	36	1-1/4 (31.75)	XDS3	XDS4
WHT	37	1-1/4 (31.75)	XDS4	XDS5
WHT	38	3/4 (19.05)	S1-5	XF1
WHT	39	3/4 (19.05)	XK1-8	XK1-1
WHT	40	1 (25.4)	XK1-6	XK1-2
WHT	41	1/2 (12.7)	XK1-3	XK1-2
WHT	42	1-1/2 (38.1)	XK1-7	TB1-50

NOTES

1. Solder. Use Federal Specification QQ-S-571, Sn 60.
2. Wire is in accordance with MIL-STD-454, requirement 20.
3. Use wire conforming to MIL-W-16878, Type 22 black or white.
4. Protect capacitor C11 leads using insulated sleeving.

Section II. MAINTENANCE OF KILOWATT METER M7

5-3. GENERAL. The KILOWATT meter M7, which is located on the control box assembly front panel, works in conjunction with thermal watt converter A1 to monitor generator output power M7 is a direct current meter (1.2 milliamperes full scale) scaled from 0 to 133 percent of total wattage. Test procedures for M7 are provided in this section.

5-4. ON-EQUIPMENT TEST. To test KILOWATT meter M7, proceed as follows:

a. Open the control box assembly front panel.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside control cubicle with generator set operating.

b. Disconnect lead going to the positive terminal of M7.

c. Connect negative probe of multimeter (set to low dc milliampere range) to positive terminal of M7.

d. Connect positive probe of mulitmeter to lead disconnected in step b.

e. Start generator set, apply load and record reading of M7 and multimeter

f. Divide reading of M7 by 133 and multiply the result by 1.2. The product should be within +/-2 percent of multimeter reading.

NOTE

Assume, for example, that M7 reading is 100. Dividing this by 133 produces 0.75. This figure, 0.75, is then multiplied by 1.2 for a result of 0.9 milliamperes. If M7 is not defective, the multimeter reading should be between 0.88 and 0.92 milliamperes.

g. Disconnect multimeter and, if meter proves not to be defective, reconnect lead to positive terminal; otherwise replace defective meter.

h. Close control box assembly front panel and secure in position.

Section III. MAINTENANCE OF WATTMETER CONVERTER A1

5-5. GENERAL. The wattmeter converter A1 senses the generator output power and converts it to a proportional dc signal for display by KILOWATT meter M7.

5-6. ON-EQUIPMENT TEST. To isolate the malfunction, proceed as follows:

NOTE

A malfunction of A1 is usually indicated by low or no KILOWATT meter reading. An open circuit coil in the wattmeter converter will also affect the PERCENT RATED CURRENT meter reading for the phase that is open.

a. Loosen three captive studs and open control box door.

b. Start generator set and apply load.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside control cubicle with generator set operating.

c. Measure input voltages at terminals V1-N1, V2-N2, and V3-N3. Voltage should be 120 V ac with the generator output voltage adjusted for rated output. If above requirement is not met, check wiring back to voltage source.

d. Measure current to terminal L1, L2, and L3. The current should vary between 0 to 0.75 AC amperes as the generator set load is varied from 0 to 100 percent of rated output. If there is no current, shut down generator set and check for continuity between terminals L1-S1, L2-S2, and L3-S3. If there is continuity, check wiring back to current source (refer to the AC Troubleshooting Diagram in the Operator and Organizational Maintenance Manual).

e. Measure the output signal at the (+) and (-) terminals with an electronic DC voltmeter. The output signal should vary between 0 to 10.4 mv as the generator set load is varied between 0 and 100 percent of rated output. If the above requirement is not met and the inputs are correct, the thermal watt converter should be replaced.

5-7. REMOVAL. Refer to the Operator and Organizational Maintenance Manual to remove the thermal watt converter.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract Skin, eye, and respiratory protection is required.

5-8. CLEANING. Clean the thermal watt converter using a clean lint-free cloth, moistened with cleaning solvent (P-D-680, Type II) and dry thoroughly.

5-9. INSPECTION. Inspect case for evidence of cracks or tears and the terminal board for cracked insulation, stripped threads, and missing jumper strips.

5-10. BENCH TEST. Connect the thermal watt converter to the test equipment as illustrated in figure 5-2 and proceed as follows:

NOTE

All test readings are +/-20 percent.

a. Adjust all autotransformers T1, T2, and T3 to their MIN positions.

b. Close switch S1 and open switches S2 and S3.

c. Energize the power source.

d. Adjust T1 until 1 ampere is indicated on ammeter A1. Voltmeter V1 should indicate 6.4 mv.

e. Close switch S2 and adjust T2 until 1 ampere is indicated on ammeter A2. Voltmeter V1 should indicate 13 mv.

f. Close switch S3 and adjust T3 until 1 ampere is indicated on ammeter A3. Voltmeter should indicate 18.6 mv.

g. Remove test equipment. Replace thermal watt converter, if defective.

5-11. INSTALLATION. Refer to the Operator and Organizational Maintenance Manual to install the thermal watt converter.

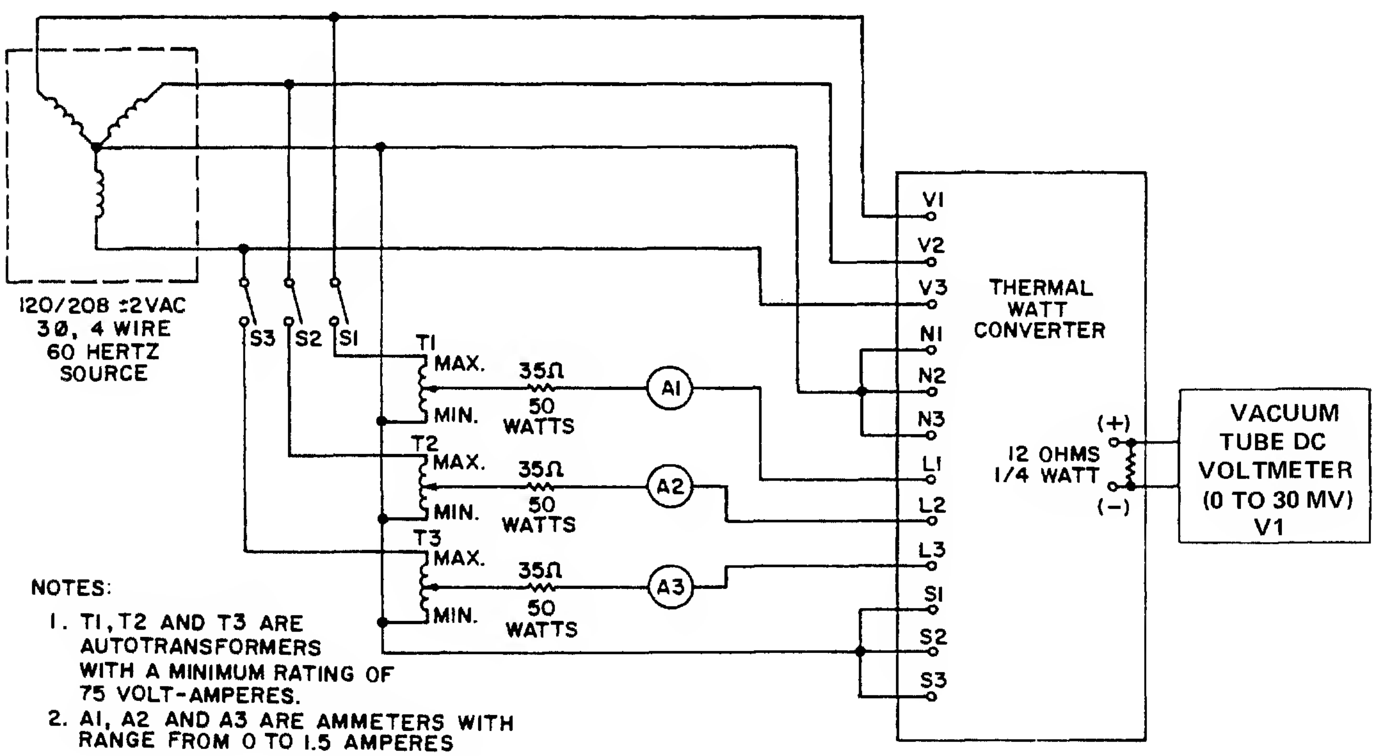


Figure 5-2. Wattmeter Converter A1, Test Setup

Section IV. MAINTENANCE OF PERCENT RATED CURRENT METER M8

5-12. GENERAL. PERCENT RATED CURRENT meter M8 monitors the generator output current.

5-13. ON-EQUIPMENT TEST. To test M8, proceed as follows:

a Loosen three captive screws and open control box door.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside control cubicle with generator set operating.

b. Connect a 0 to 1 ampere ac test ammeter in series with M8 (disconnect one of leads going to M8).

c. Both meters should read the same current to within +/-2 percent of each other.

d. If there is no current reading on either meter, check wiring back to its source (refer to the AC Troubleshooting Diagram in the Operator and Organizational Maintenance Manual)

e. Replace meter M8, if its reading is not within tolerance.

5-14. REMOVAL. Refer to the Operator and Organizational Maintenance Manual and remove meter M8.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

5-15. CLEANING. Clean meter M8 using a clean, lint-free cloth, moistened with cleaning solvent (P-D-680, Type II) and dry thoroughly.

5-16. INSPECTION. Inspect case for signs of cracks and electrical terminals for security. Check for broken or bent dial pointer and for cracked glass.

5-17. TEST. To test meter M8 connect it to the test setup illustrated in figure 5-3 and proceed as follows:

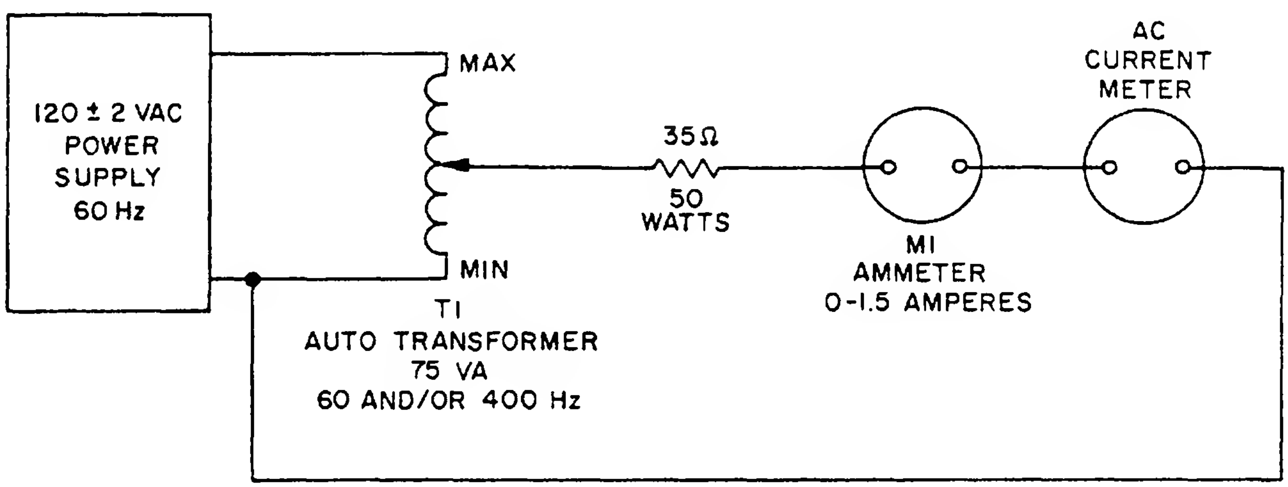


Figure 5-3. Percent Rated Current Meter M8, Test Setup

a. Adjust autotransformer T1 so that ammeter M1 reads 1 ampere. AC current meter should indicate 133 percent load.

b. Adjust autotransformer T1 so that meter M1 reads 0.75 ampere. AC current meter should indicate 100 percent load.

c. Remove test equipment. Replace AC current meter if meter error is greater than 2 percent of full scale value.

5-18. INSTALLATION. Refer to the Operator and Organizational Maintenance Manual and install meter M8.

Section V. MAINTENANCE OF HERTZ (FREQUENCY) METER M6 AND FREQUENCY TRANSDUCER A2

5-19. GENERAL. HERTZ (frequency) meter M6 works in conjunction with frequency transducer A2 to sense and indicate generator set output frequency in Hertz. It is scaled from 48 to 53 Hertz for 50 Hertz operation and from 57 to 62 Hertz for 60 Hertz operation. Scale divisions are 1/10 Hertz.

5-20. ON-EQUIPMENT TEST. To test M6 and A2 proceed as follows:

a. Loosen three captive studs and open control box door.

b. Start generator set and apply load.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside control cubicle with generator set operating.

c. Measure input voltage to frequency transducer A2 at terminal 1 and 2. Voltage should be 120 +/-10 percent V ac, if not, check wiring back to voltage source (refer to the AC Troubleshooting Diagram in the Operator and Organizational Maintenance Manual).

d. Connect a test frequency meter to the convenience receptacle or generator output terminal. Check panel frequency meter accuracy against test meter while varying engine speed using manual speed control. If meters do not indicate within 1 percent of each other, replace frequency meter and transducer.

5-21. REMOVAL. Refer to the Operator and Organizational Maintenance Manual to remove meter M6 and transducer A2.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

5-22. CLEANING. Clean frequency meter M6 and transducer A2 using a clean lint-free cloth, moistened with cleaning solvent (P-D-680, Type II) and dry thoroughly.

5-23. INSPECTION. Inspect frequency meter M6 and transducer A2 cases for cracks or tears and the electrical connectors for bent pins and insulation breakdown.

5-24. TEST. To test M6 and A2, proceed as follows:

All data on this page deleted in its entirety.

a. Loosen three captive screws and open control box door.

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside control cubicle with generator set operating.

NOTE

Steps b through g pertain to stop-run relay K1 and steps h through j pertain to remote voltage sensing relay K6. All test readings should be +/-20 percent.

b. Set DC circuit breaker to on.

c. Start engine. If engine shuts down when START-STOP-RUN switch is positioned to RUN, restart engine and hold switch to START. Measure voltage at relay assembly terminal board across terminals 2 and 8. Voltage should be 24 V dc.

d. If voltage across terminals 2 and 8 is not 24 V dc, shut down generator set. Disconnect wire P50A from terminal 9 and insulate wire end.

e. Restart generator set and, using an ohmmeter, check continuity across terminals 7 and 9. There should be continuity. Connect wire P50A.

f. If reading across terminals 7 and 9 is not correct, shut down generator set. Remove wire P80E from terminal 8 and check resistance across terminals 2 and 8. Resistance should be 300 ohms. If not replace stop-run relay K1.

g. If values in steps b through f are met and circuit is still inoperative, remove and bench test control box relay assembly A4

h. Connect a suitable cable between one of the convenience receptacle outlets (J55) and remote voltage sensing connector (J29). Set convenience receptacle circuit breaker (CB3) to OFF. Start engine and position the remote local voltage switch (S5) to the REMOTE position and set convenience receptacle circuit breaker (CB3) to ON. Measure voltage at relay assembly terminal board across terminals 4 and 12, 5 and 11, 6 and 10. Voltage should be 120 V ac nominal.

i. If voltages in step h are correct and the remote voltge sensing circuit is still inoperative, shut down generator set. Remove wires X29A and X31A from terminals 4 and 12. Measure resistance at terminals, resistance should be approximately 7K ohms. If not replace remote voltage sensing relay K6.

j. If values in steps h and i are obtained and circuit is still inoperative, replace control box relay assembly A4.

5-28. REMOVAL.

a. Disconnect connector J1 at rear of control cubicle.

b. Loosen three captive studs and hinge open control box door.

c. Tag and disconnect wiring to control box relay assembly terminal boards.

NOTE

The control box relay assembly is mounted inside the control box on the lower rear wall.

d. Remove the four nuts located at the back of the rear wall, securing the control box relay to the control cubicle assembly.

5-29. TEST.

a. Connect the control box relay assembly to the test equipment as illustrated in figure 5-5.

b. Perform test specified in table 5-2.

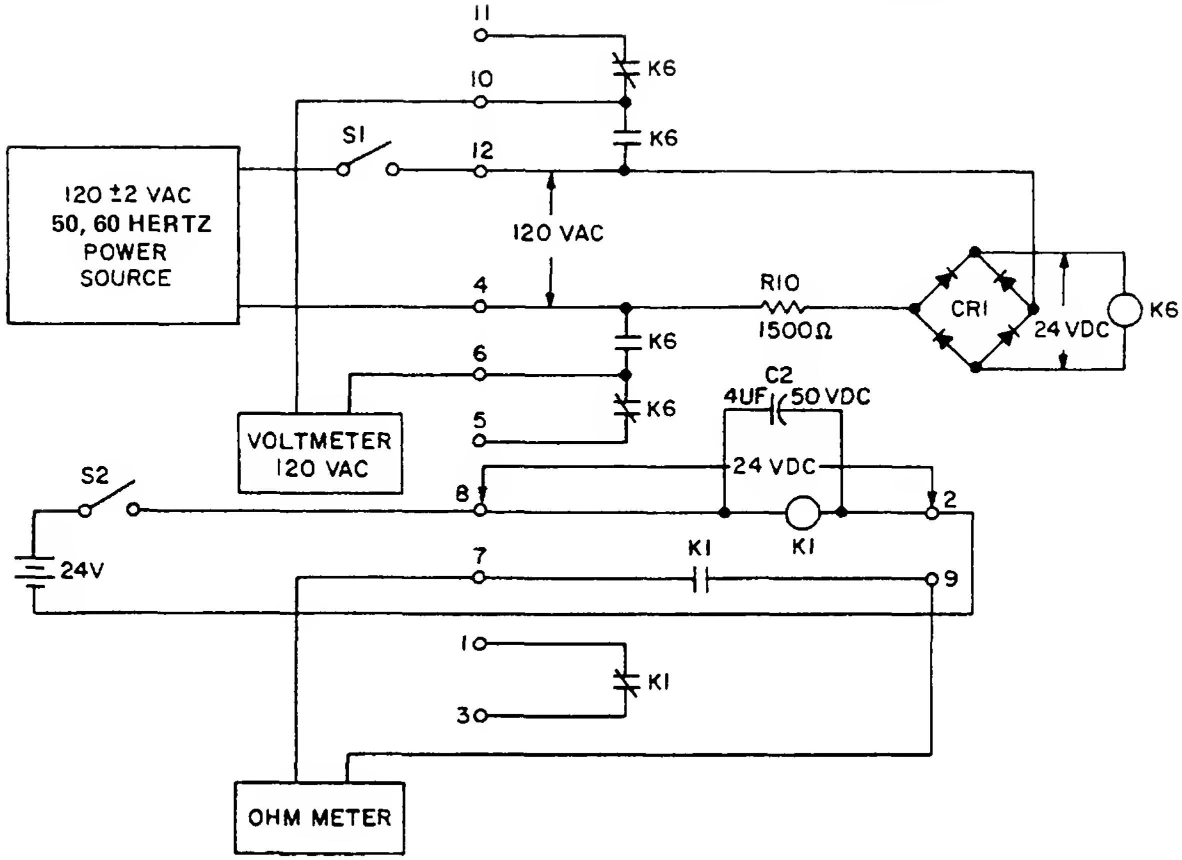


Figure 5-5. Control Box Relay Assembly A4, Test Setup

NOTE

All voltage values are +20 percent.

5-30. DISASSEMBLY. Refer to figure 5-6.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

CAUTION

Exercise care when unsoldering components to avoid damage resulting from application of excessive heat. Use heat sink, if possible.

NOTE

Test control box relay assembly as outlined in paragraph 5-29, then disassemble only to the extent necessary to effect repair.

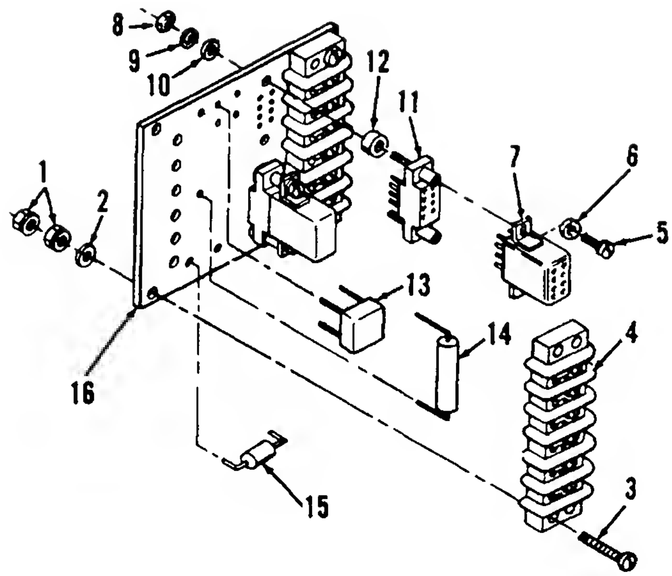
5-31. CLEANING. Clean the control box relay assembly using a clean lint-free cloth, moistened with cleaning solvent (P-D-680, Type II) and dry thoroughly.

5-32. INSPECTION. To inspect A4, proceed as follows:

a. Inspect terminal boards for cracked insulation, circuit integrity, warping, burned or discolored areas and illegible stenciling.

Table 5-2. Control Box Relay Assembly A4, Procedural Analysis

STEP	TEST CONDITION	REQUIRED RESULT	PROBABLE CAUSE FOR IMPROPER RESULT	CHECK OUT PROCEDURE
	WARNING Exercise extreme care when applying high voltages: death or injury to personnel may result.			
	CAUTION When applying 120 V ac voltages to control box relay assembly terminals, ensure correct placement of power leads. Damage to other components could result if leads are misplaced.			
1.	Apply 120 V ac, 60 Hz power supply to terminals 4 and 12 of the control box relay assembly. Measure voltage at terminals 6 and 10.	Voltage measured should be 120 V ac. (If voltage is incorrect check voltage across coil of K6, it should be 24 V dc.)	Resistor R10 defective. (If required 24 V dc is absent.)	Check resistor with ohmmeter.
			Full wave rectifier bridge CR1 defective. (If required 24 V dc is absent.)	Check CR1 with ohmmeter.
			Defective relay K6. (If required 24 V dc is present.)	Replace defective relay.
2.	Apply 24 V dc power supply across terminals 2 and 8 of control panel relay assembly. Check continuity across terminals 7 and 9 with ohmmeter.	There should be continuity across terminals 7 and 9.	Defective relay K1.	Replace defective relay.



1. NUT
2. WASHER
3. SCREW
4. TERMINAL BOARD
5. SCREW
6. WASHER
7. RELAY
8. NUT
9. WASHER
10. LOCKWASHER
11. RELAY SOCKET
12. SPACER
13. SILICONE BRIDGE RECTIFIER
14. FIXED RESISTOR
15. CAPACITOR
16. TERMINAL BOARD

Figure 5-6. Control Box Relay Assembly A4, Exploded View

b. Check forward and reverse resistance of diodes. Measured from anode (+) to cathode (-), value should be low. Reverse leads, value should be at least 100 times low value.

c. Check resistor for proper ohmic value (15K ohms).

d. Check capacitor for rated value.

e. Inspect relay sockets for cracked insulation and broken pin receptacles.

f. Test plug in relays for actuation as illustrated in figure 5-7.

5-33. REPAIR. To repair A4, proceed as follows:

a. Restencil illegible reference designations.

b. Repair printed circuits by soldering a jumper wire across defective area.

c. Replace all defective components.

d. Solder replacement components using solder conforming to Federal Specification QQ-S-571 Sn60.

5-34. REASSEMBLY. To reassemble A4 refer to figure 5-6 and proceed as follows:

a. When replacing soldered components, use a suitable heat sink. Solder joint and/or component leads shall not project more than 0.094 inch (2.3 mm) beyond the surface of the board.

b. Spray or brush a conformal coating, 0.005 inch (0.127 mm) thick, or a transparent dielectric compound corresponding to Specification MIL-I-46058, Grade S, Type PUR to the assembly.

NOTE

The compound shall securely anchor the components to the terminal board. Terminals for connection to external circuits shall not be coated.

c. Test control box relay assembly as outlined in paragraph 5-29.

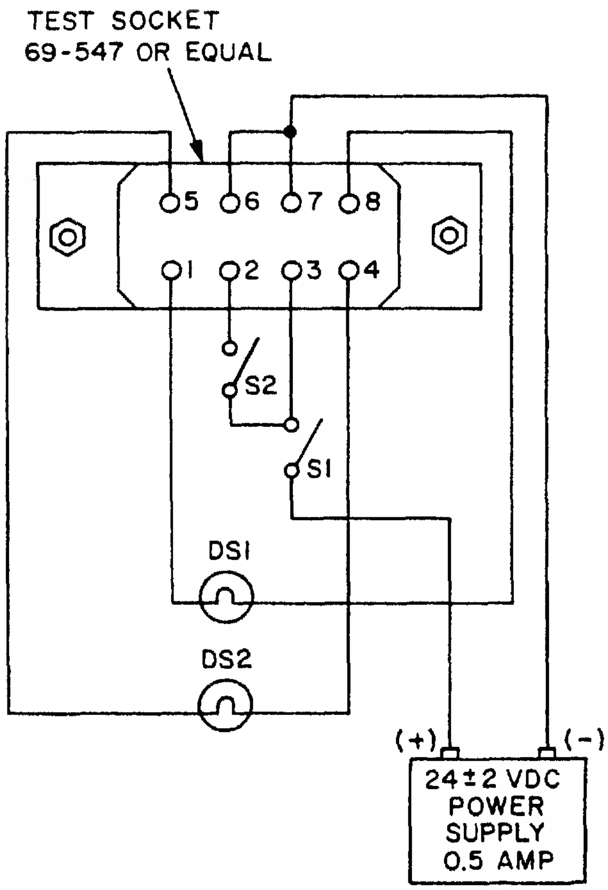
5-35. INSTALLATION. To install A4, proceed as follows:

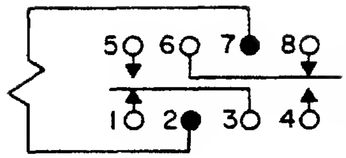
a. Position the control box relay assembly inside the control cubicle and secure it to the rear wall with four nuts.

b. Connect wiring to the control box relay assembly terminal boards. Refer to the Operator and Organizational Maintenance Manual and check wires for proper connection.

c. Close and secure control box door.

d. Connect harness at rear of control cubicle.





NOTE:
INTERNAL CONNECTIONS
BOTTOM ORIENTATION OF
RELAY.

PROCEDURE:

STEP 1. PLUG RELAY INTO TEST SOCKET. TURN ON POWER SUPPLY.

STEP 2. CLOSE SWITCH S1; INDICATOR DS1 SHOULD LIGHT.

STEP 3. CLOSE SWITCH S2; INDICATOR DS2 SHOULD LIGHT AND INDICATOR DS1 SHOULD GO OUT.

STEP 4. TURN OFF POWER SUPPLY AND REMOVE RELAY FROM TEST EQUIPMENT. REPLACE DEFECTIVE RELAY.

Figure 5-7. Plug-In Relay, Test Setup

CHAPTER 6

MAINTENANCE OF AC ELECTRICAL CONTROL SYSTEM

Section I. MAINTENANCE OF TACTICAL RELAY BOX ASSEMBLY A29

6-1. GENERAL. The tactical relay box A29 contains overvoltage relay K2, reverse power relay K15, short circuit relay K13, overload relay K14, and three current transformer load resistors.

6-2. ON-EQUIPMENT TEST. To test tactical relay box A29, proceed as follows:

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside tactical relay box with generator set operating.

NOTE

A malfunction of the tactical relay box A29 is usually indicated by a malfunction of one of the four protective relays K2, K15, K43, and K14 or current transformer load resistors R23, R24, or R25.

a. Remove cover from tactical relay box A29 to gain access to test points (refer to figure 6-1).

b. To test overvoltage relay K2, refer to paragraph 6-34.

c. To test reverse power relay K15, refer to paragraph 6-35.

d. To test short circuit relay K13, refer to paragraph 6-36.

e. To test overload relay K14, refer to paragraph 6-37. If K14 does not test correctly, disconnect, isolate, and tag wires leading to terminals A, B, and C of K14 and, using a multimeter check resistors R23, R24, and R25 for a value of 7.5 ohm each.

6-3. REMOVAL. For instructions on removing tactical relay box A29, refer to figure 6-1.

6-4. TEST. To test tactical relay box A29, proceed as follows:

a. Using a multimeter set to low ohms, check that continuity exists between the following pins of connectors J51 and J4:

(1) J51-S and J4-A
(2) J51-R and J4-B
(3) J51-d and J4-G
(4) J51-V and J4-F
(5) J51-U and J4-E
(6) J51-T and J4-D
(7) J51-X and J4-N
(8) J51-N and J4-S
(9) J51-J and J4-C
(10) J51-K and J4-M
(11) J51-K and J4-K
(12) J51-K and J4-L.

b. Connect tactical relay box A29 to test setup shown in figure 6-2.

c. Perform test specified in table 6-1.

6-5. REPAIR AND OVERHAUL. To repair or overhaul tactical relay box A29, proceed as follows:

NOTE

Repair of A29 consists of replacing defective relays K2, K15, K13, or K14, resistors R23, R24, or R25, or repairing the harness assembly. Overhaul consists of replacing all of above components and fabricating the wiring harness.

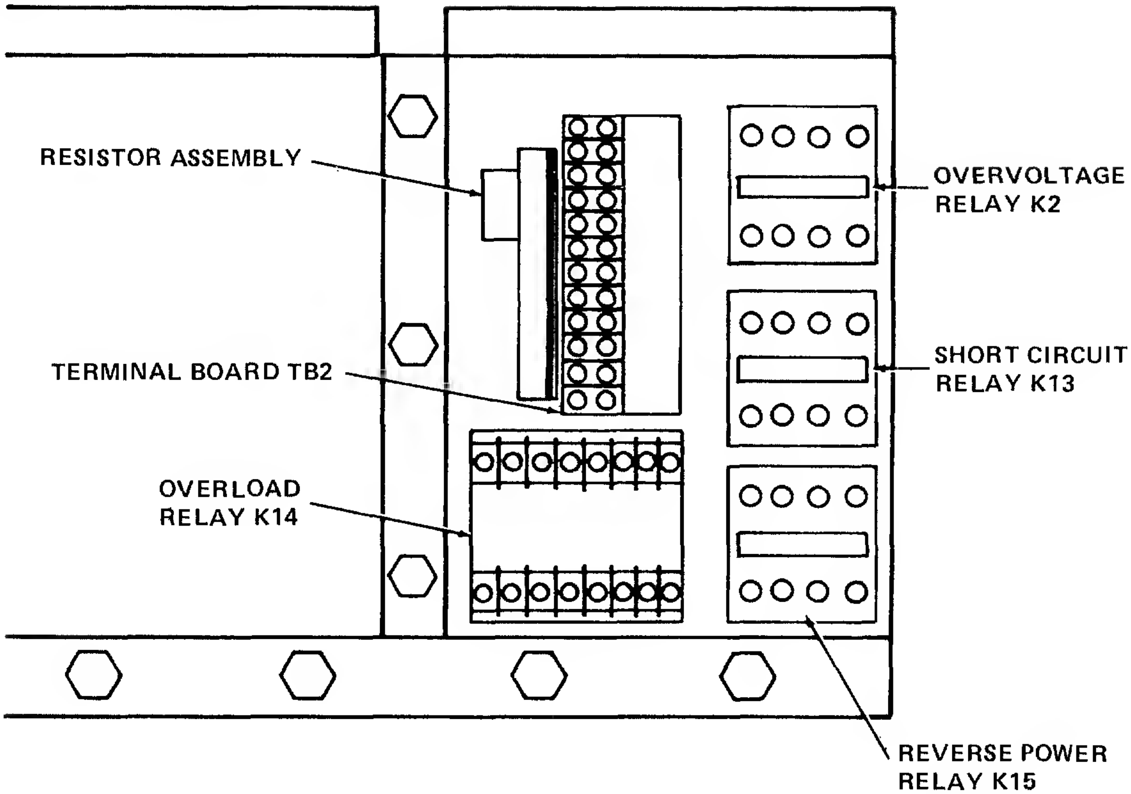


Figure 6-1. Tactical Relay Box A29, Cover Removed

NOTES:
1. REMOVE THE FOUR CORNER SCREWS AND WASHERS SECURING THE COVER TO THE CHASSIS TO GAIN ACCESS TO THE TEST POINTS.
2. TACTICAL RELAY BOX MUST BE REMOVED FROM GENERATOR SET TO ACCOMMODATE REPLACEMENT OF RELAYS. TO REMOVE THE BOX ASSEMBLY, TAG AND DISCONNECT THE TWO ELECTRICAL PLUG CONNECTORS AT J4 AND J51, THEN REMOVE TWO SCREWS AND WASHERS SECURING THE BOX IN POSITION.
3. REPLACE ASSEMBLY BY REVERSING ABOVE PROCEDURES.

a. Repair or fabricate wiring harness in accordance with figure 6-3 and paragraph 6-66.

WARNING

Paint is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

b. Straighten dented or distorted sheet metal parts using proper tools. Blend in repaired area with a fine abrasive paper and touch up painted surfaces using olive drab, per MIL-T-704, Type A, semi-gloss, No. X24087. Restencil panel markings as necessary.

6-6. INSTALLATION. To install tactical relay box A29, proceed as follows (refer to figure 6-1):

a. Secure tactical relay box A29 in position on mounting bracket with two screws and washers.

b. Connect plug J4 and J51 to side of tactical relay box.

c. Secure cover in place with four screws and washers.

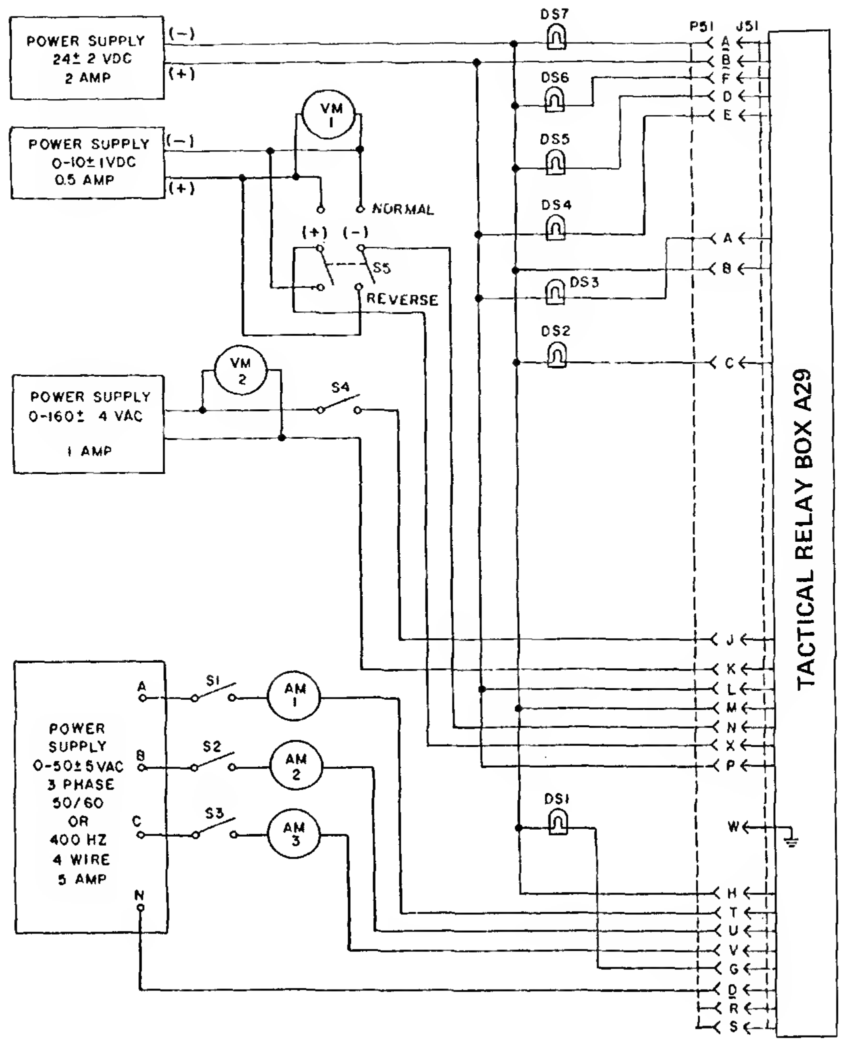


Figure 6-2. Tactical Relay Box A29, Test Setup

Table 6-1. Tactical Relay Box A29, Procedural Analysis

STEP	TEST CONDITION	REQUIRED RESULT	PROBABLE CAUSE FOR IMPROPER RESULT	CHECK OUT PROCEDURE
1.	Energize 24 V dc power supply.	Indicator lights DS3, DS4 and DS7 should light.		
2.	Energize 0 to 10 V dc power supply and set ouput to 0 V dc.			
2.a.	Position switch S5 so that J51-X is positive, then slowly adjust, voltage of 0 to 10 V dc power supply from 0 to 10 V dc; return voltage to 0 V dc.	Indicator light DS4 should stay lit.	Defective reverse power relay K15.	Test relay in accordance with paragraph 6-40.
2.b.	Position switch S5 so that J51-N is positive, then slowly increase voltage of 0 to 10 V dc power supply to 2 ±0.5 V dc.	Indicator light DS4 should go out and DS5 should light.	Defective reverse power relay K15.	Test relay in accordance with paragraph 6-40.
2.c.	Return voltage of 0 to 10 V dc power supply to 0 V dc.	Indicator light DS4 should light and DS5 should go out.	Defective reverse power relay K15.	Test relay in accordance with paragraph 6-40.
3.	Energize 0 to 160 V ac power supply.			

Table 6-1. Tactical Relay Box A29, Procedural Analysis (Continued)

STEP	TEST CONDITION	REQUIRED RESULT	PROBABLE CAUSE FOR IMPROPER RESULT	CHECK OUT PROCEDURE
3.a.	Adjust voltage to 156 V ac and close switch S4.	Indicator light DS3 should go out and DS2 should light.	Defective overvoltage relay K2.	Test relay in accordance with paragraph 6-39.
3.b.	Deenergize 0 to 160 V ac power supply.	Indicator light DS3 should light and DS2 should go out.	Defective overvoltage relay K2.	Test relay in accordance with paragraph 6-39.
4.	Energize 0 to 50 V ac power supply. Close switches S1, S2 and S3, then adjust power supply to obtain 3.375 amperes on ammeters AM1, AM2, and AM3. Open switches S1, S2 and S3.			
4.a.	Close and open switches S1, S2, and S3 in order listed.	Indicator light DS7 should go out and DS6 light as each switch is closed and opened.	Defective short circuit relay K13.	Test relay in accordance with paragraph 6-41.
4.b.	Reduce voltage to 0 V ac.			

Table 6-1. Tactical Relay Box A29, Procedural Analysis (Continued)

STEP	TEST CONDITION	REQUIRED RESULT	PROBABLE CAUSE FOR IMPROPER RESULT	CHECK OUT PROCEDURE
5.	Close switches S1, S2, and S3, then adjust 0 to 50 V ac power supply to obtain 0.75 amperes.			
5.a.	Adjust A phase voltage to obtain 0.957 ampere on AM1.	Indicator light DS4 should go out and DS1 should light within 6 to 10 minutes.	Defective overload relay K14.	Test relay in accordance with paragraph 6-42.
5.b.	Readjust 0 to 50 V ac power supply to 0.75 amperes.	Indicator light DS4 should light and DS1 should go out.	Defective overload relay K14.	Test relay in accordance with paragraph 6-42.
5.c.	Repeat step 5.a. for Phase B and C.	Same as step 5.a.	Defective overload relay K14.	Test relay in accordance with paragraph 6-42.
5.d.	Turn off all power supplies.			

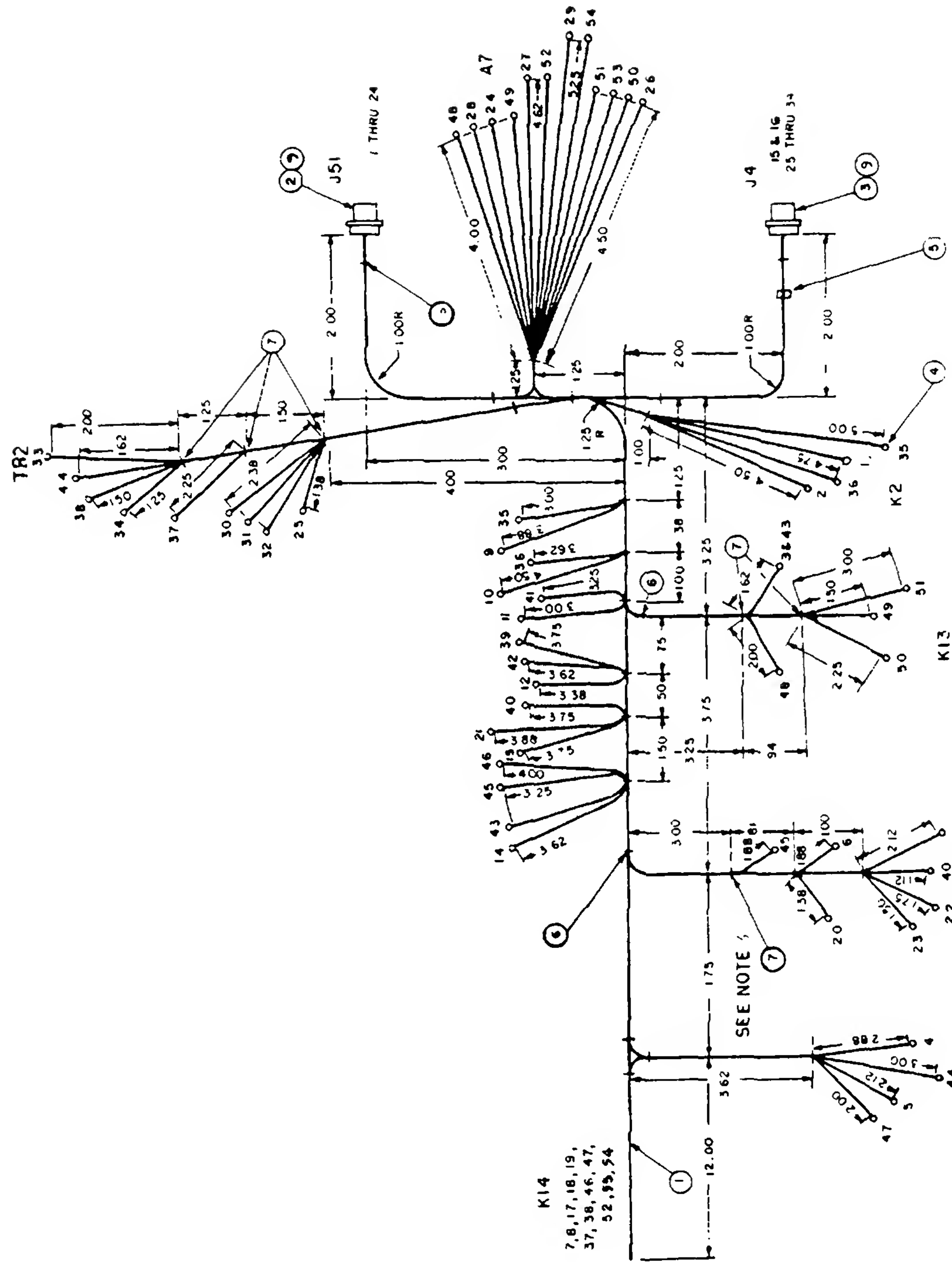


Figure 6-3. Tactical Relay Box A29, Wiring Harness (Sheet 1 of 2)

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERMN FIND NO.	TO	TERMN FIND NO.	LG REF
1	BLACK	P58D16	J51-A	2	K2-3	4	10.00
2	BLACK	P50T16	J51-B		K2-4	4	10.00
3	BLACK	P206D16	J51-C		K2-7	4	12.25
4	BLACK	P205D16	J51-D		K15-6	4	18.25
5	BLACK	P60A16	J51-E		K15-7	4	17.75
6	BLACK	P203D16	J51-F		K13-7	4	15.75
7	BLACK	P209D16	J51-G		K14-NO	4	26.00
8	BLACK	P62K16	J51-H		K14-NC	4	26.00
9	BLACK	X9W16	J51-J		TB2-1	4	8.75
10	BLACK	X12CC16	J51-K		TB2-2	4	9.25
11	BLACK	P50BB16	J51-L		TB2-4	4	9.75
12	BLACK	P55BB16	J51-M		TB2-5	4	10.25
13	BLACK	K102D16	J51-N		TB2-6	4	11.00
14	BLACK	P200U16	J51-P		TB2-8	4	12.50
15	BLACK	X8K16	J51-R		J4-B	3	8.00
16	BLACK	X7K16	J51-S		J4-A	3	8.00
17	BLACK	X17E16	J51-T		K14-A1	4	26.00
18	BLACK	X18E16	J51-U		K14-B1	4	26.00
19	BLACK	X19E16	J51-V		K14-C1	4	26.00
20	BLACK	P55BH16	J51-W		GRD LUG	4	17.00
21	BLACK	K101D16	J51-X		TB2-7	4	11.50
22	BLACK	P63A16	J51-a		K13-5	4	16.50
23	BLACK	P62F16	J51-b		K13-6	4	16.50
24	BLACK	D24F16	J51-d	2	A7-TB1-4	4	7.50
25	BLACK	X9Y16	J4-C	3	TB2-1	4	9.50
26	BLACK	X116B16	J4-E	3	A7-TB1-2	4	10.00
27	BLACK	X117B16	J4-F	3	A7-TB1-3	4	10.00
28	BLACK	D24J16	J4-G	3	A7-TB1-4	4	9.50
29	BLACK	X115B16	J4-D		A7-TB1-1	4	10.50
30	BLACK	X12HH16	J4-K		TB2-3	4	10.00
31	BLACK	X12KK16	J4-L		TB2-3	4	10.00
32	BLACK	X12DD16	J4-M		TB2-2	4	10.50
33	BLACK	K101B16	J4-N		TB2-7	4	12.50
34	BLACK	K102B16	J4-S	3	TB2-6	4	12.00
35	BLACK	X9X16	TB2-1	4	K2-1	4	10.25
36	BLACK	X12FF16	TB2-2	4	K2-2	4	11.00
37	BLACK	P50DD16	TB2-4	4	K14-(+)	4	28.50
38	BLACK	P55JJ16	TB2-5	4	K14-(-)	4	29.00
39	BLACK	K102C16	TB2-6	4	K15-1	4	12.00
40	BLACK	K101C16	TB2-7	4	K15-2	4	12.00
41	BLACK	P50CC16	TB2-4	4	K15-3	4	13.00
42	BLACK	P55NN16	TB2-5	4	K15-4	4	12.50
43	BLACK	P200Z16	TB2-8	4	K2-8	4	10.00
44	BLACK	P200Y16	TB2-8	4	K15-5	4	23.00
45	BLACK	P200W16	TB2-9	4	K13-8	4	10.00
46	BLACK	P200X16	TB2-9	4	K14-NO	4	19.00
47	BLACK	P61A16	K15-8	4	K14-NC	4	18.00
48	BLACK	D24H16	A7-TB1-4	4	K13-4	4	13.75
49	BLACK	X117D16	A7-TB1-3	4	K13-3	4	14.50
50	BLACK	X116D16	A7-TB1-2	4	K13-2	4	16.75
51	BLACK	X115D16	A7-TB1-1	4	K13-1	4	16.50
52	BLACK	X117C16	A7-TB1-3	4	K14-C2	4	28.00
53	BLACK	X116C16	A7-TB1-2	4	K14-B2	4	28.00
54	BLACK	X115C16	A7-TB1-1	4	K14-A2	4	28.50

FIND NO	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
9			TYPE F. FORM Ua GRADE a. CL I CATEGORY 1	34	TUBING, INSULATION .106 ID X .016 WALL X .62 LG	MIL-I-631	
8			SN60WRAP2	AR	SOLDER, LEAD-TIN-ALLOY, ROSIN CORE	QQ-S-751	NOTE 3
7			MS3367-4-9	8	STRAP, TIEDOWN		NYLON
6			MS3367-1-9	19	STRAP, TIEDOWN		NYLON
5			MS39020-1	1	BAND, MARKER		AL ALY
4			MS25036-106	72	TERMINAL, LUG, CRIMP STYLE		
3			MS3102R20-29P	1	CONNECTOR, PLUG		
2			MS3102R28-12P	1	CONNECTOR, PLUG		
1			M5086/2-16-9	AR	WIRE, ELECTRICAL	MIL-W-5086/2	

NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 8.
3. CABLE STRAPS, FIND NO. 6 AND 7, SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.

WIRE LENGTH TOLERANCES		
OVER	INCL	TOL ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

Figure 6-3. Tactical Relay Box A29, Wiring Harness (Sheet 2 of 2)

Section II. MAINTENANCE OF MODE I RELAY BOX ASSEMBLY A27

6-7. GENERAL. The Mode I relay box assembly A27, which is a junction box for certain electronic components, contains dc relay assembly A5, engine crank relay K3, battery charging ammeter shunt R13, and wiring harnesses. Mounted on assembly A5 are: field flash relay K5; parallel operation voltage sensor rectifier bridge CR4 and relay K7; fuel level relay K8; diodes CR3 and CR6; and paralleling lights resistors R6 through R9.

NOTE

A malfunction of A27 is usually indicated by a failure of dc relay assembly A5, a failure of the engine to crank, or unequal reactive load sharing when the generator set is operated in parallel.

6-8. ON-EQUIPMENT TEST. To test Mode I relay box assembly A27 proceed as follows:

a. Remove cover from A27 to gain access to test points (refer to figure 6-4).

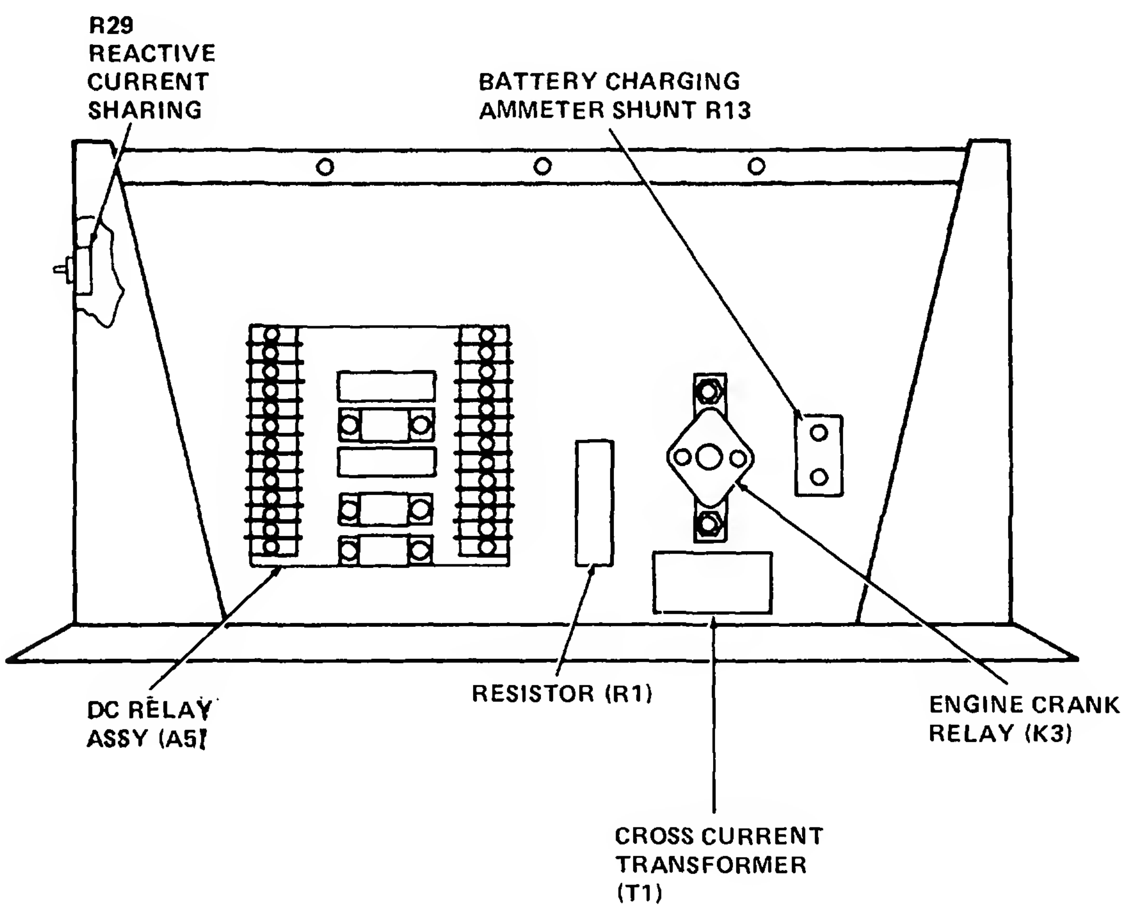


Figure 6-4. Mode I Relay Box Assembly A27, Cover Removed

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside A27 with generator set operating.

b. To test engine crank relay K3, refer to the Operator and Organizational Maintenance Manual.

c. To test field flash relay K5, refer to the Operator and Organizational Maintenance Manual.

d. To test fuel level relay K8, refer to the Operator and Organizational Maintenance Manual.

6-9. REMOVAL. To remove Mode I relay box assembly A27, proceed as follows:

a. Remove and tag all connector plugs going to A27.

b. Remove four screws and nuts securing A27 to mounting bracket.

c. Remove Mode I relay box assembly A27.

6-10. TEST. To test Mode I relay box assembly A27, proceed as follows:

a. Using a multimeter set to low ohms, check that continuity exists between the points listed in table 6-2.

b. Connect Mode I relay box A27 to test setup shown in figure 6-5.

c. Perform test specified in table 6-3.

6-11. REPAIR AND OVERHAUL. To repair or overhaul Mode I relay box assembly A27, proceed as follows:

NOTE

Repairing A27 consists of replacing defective relays K3, K5, K7, or K8; resistors R1, R6, R7, R8, R9, or R13; diodes CR3, CR4, or CR6; or repairing the harness assembly. Overhaul consists of replacing all of above components and fabricating the harness assembly.

a. Repair or fabricate harness assembly in accordance with figure 6-6 and paragraph 6-66.

WARNING

Paint is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

b. Straighten dented or distorted sheet metal parts using proper tools. Blend in repaired area with a fine abrasive paper and touch up painted surfaces using olive drab, per MIL-T-704, Type A, semi-gloss, No. X24087. Restencil panel markings as necessary.

6-12. INSTALLATION. To install Mode I relay box A27, proceed as follows:

a. Secure A27 in place on mounting bracket with four screws and nuts.

b. Reconnect connector plugs as indicated by tags applied during removal.

Table 6-2. Mode I Relay Box Assembly A27, Continuity Test

FROM	TO
J50-L	J50-B
J50-L	J2-W
J50-L	J31-E
J50-L	J10-N
J50-L	J10-E
J50-L	J5-K
J50-L	J5-C
J50-L	J5-E
J50-L	A5-21
J50-P	J31-K
J50-P	J6-C
J50-P	J5-M
J50-P	J5-Z
J50-P	J5-W
J50-P	A5-17
J50-R	J2-F
J50-R	J10-B
J50-S	J2-E
J50-S	J10-A
J50-H	J50-B
J50-H	J2-H
J50-W	J2-P
J50-W	J2-R
J50-W	J50-M
J50-W	J31-D
J50-W	J31-Z
J50-W	J7-A
J50-W	J10-L
J50-W	J29-E
J50-W	J5-T
J50-W	J5-U
J50-W	J5-H
J50-W	J5-G
J50-W	J5-S
J50-W	K3-X1
J50-W	A5-15

FROM	TO
J50-J	J31-A
J50-J	J2-Z
J50-J	J10-C
J50-J	A5-18
J50-K	J31-B
J50-K	J10-W
J50-K	J2-Y
J50-D	J2-D
J50-V	J10-D
J50-U	J10-E
J50-T	J10-F
J50-A	J10-M
J50-E	J31-L
J50-X	J31-U
J50-N	J31-S
J2-T	J31-H
J2-H	J31-R
J2-H	J10-B
J2-L	J3-A
J2-M	J31-M
J2-N	J31-N
J2-T	J31-T
J2-B	J31-P
J2-C	J5-G
J2-X	J5-H
J2-V	J5-I
J2-W	J5-J
J2-X	J5-K
J2-Y	J5-Z
J2-Y	J7-E
J2-Z	R13-3
J2-P	T1-2
J2-S	J29-B
J2-U	R1-2
J2-A	J10-J
J2-B	J10-H
J2-C	J10-G

Table 6-2. Mode I Relay Box Assembly A27, Continuity Test (Continued)

FROM	TO	FROM	TO
J2-G	J10-A	J5-D	J5-F
J2-I	J10-D	J5-D	A5-24
J2-J	A5-19		
J2-K	A5-8	J5-A	J6-K
J2-O	J29-C	J5-B	J6-E
J2-A	J10-F	J5-C	J6-D
J2-U	J29-A	J5-Z	R13-1
J2-V	A5-1	J5-M	A5-1
		J5-U	A5-12
J2-K	J29-H	J5-V	A5-13
J2-K	J10-C	J5-Y	A5-4
		J5-B	A5-6
J2-M	J5-P		
J2-M	J5-P	J15-J	J15-E
J2-M	J5-R	J15-J	J15-A
		J15-J	J10-G
J2-N	J2-V	J15-F	J31-J
J2-N	J3-B	J15-F	J15-K
		J15-F	J15-B
J2-E	J29-F		
J2-E	A5-16	J15-L	J15-G
J2-E	J5-N	J15-L	J15-C
		J15-L	J10-H
J2-G	J5-D		
J2-G	J29-G	J15-M	J15-H
		J15-M	J15-D
J2-R	J6-A	J15-M	T1-1
J2-R	J29-D		
		J10-K	J31-G
J50-C	J6-I	J10-J	R29-2
J50-D	J6-H	J10-X	A5-22
J50-F	J6-F	J10-Y	R29-1
J50-G	J6-M	J10-Z	R29-3
J50-A	J5-E	J10-T	A5-7
		J10-S	A5-20
J5-F	J31-C		
J5-J	K3-A1	J3-C	A5-14
J5-W	R13-4	J3-D	A5-2
J5-W	K3-A2	J31-F	J6-G
J5-W	J5-L	J6-B	A5-3
		J6-L	A5-5
		R1-1	T1-4
		R1-2	T1-3

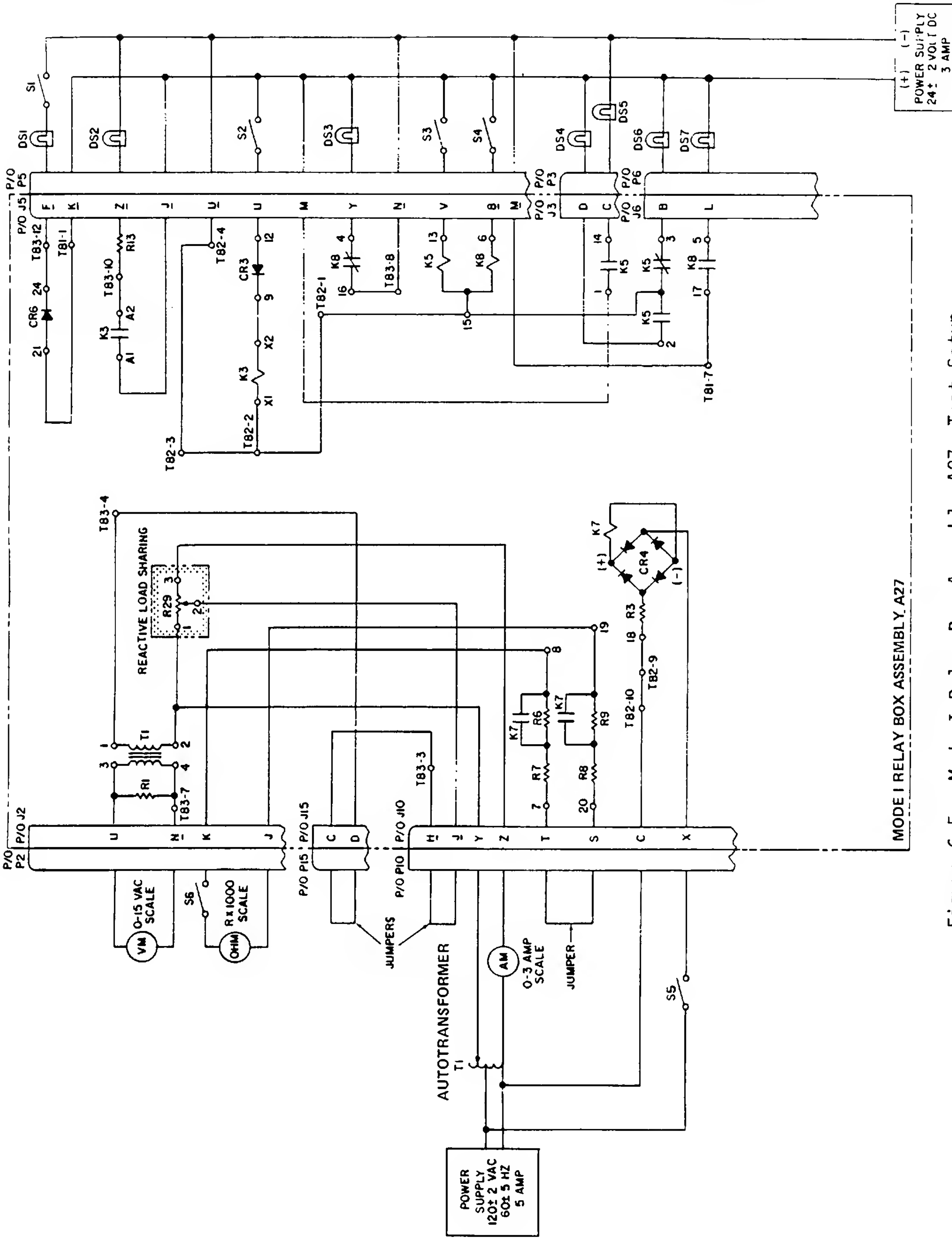


Figure 6-5. Mode I Relay Box Assembly A27, Test Setup

Table 6-3. Mode I Relay Assembly A27, Procedural Analysis

STEP	TEST CONDITION	REQUIRED RESULT	PROBABLE CAUSE FOR IMPROPER RESULT	CHECK OUT PROCEDURE
1.	Open all test switches.			
2.	Energize the 24 V dc power source.	Indicator lights DS3 and DS6 should light.	Defective relays K5 and K8.	Test relays as outlined in Operator and Organizational Maintenance Manual.
3.	Close switch S1.	Indicator light DS1 should light.		
3.a.	Temporarily reverse leads coming from 24 V dc power supply. Return power supply leads to original position.	Indicator light DS1 should go out.	Defective diode CR6.	Check diode.
4.	Close switch S2.	Indicator light DS2 should light.	Defective relay K3, resistor R13, or diode CR3.	Test relay as outlined in Operator and Organizational Maintenance Manual. Check diode and resistor.
5.	Close switch S3.	Indicator light DS6 should go out and DS4 and DS5 should light.	Defective relay K5.	Test relay as outlined in Operator and Organizational Maintenance Manual.
6.	Close switch S4.	Indicator light DS3 should go out and DS7 should light.	Defective relay K8.	Test relay as outlined in Operator and Organizational Maintenance Manual.

Table 6-3. Mode I Relay Assembly A27, Procedural Analysis (Continued)

STEP	TEST CONDITION	REQUIRED RESULT	PROBABLE CAUSE FOR IMPROPER RESULT	CHECK OUT PROCEDURE
7.	Turn on AC power supply and close switch S5.	Ohmmeter should read 5K ohms.	Defective relay K7. Open resistors R7 or R8.	Test relay as outlined in Operator and Organizational Maintenance Manual. Check resistors.
8.	Open switch S5.	Ohmmeter should read 15K ohms.	Defective relay K7. Open resistors R6 or R9.	Test relay as outlined in Operator and Organizational Maintenance Manual. Check resistors.
9.	Adjust transformer T1 so that ammeter reads 1.5 ±0.1 amperes.	Voltmeter should indicate 0 to 9 V ac as reactive load sharing rheostat R29 is varied full range.	Defective resistor R1, transformer T1 or rheostat R29.	Check resistor, transformer, and rheostat.
10.	Turn off AC and DC power supplies.			

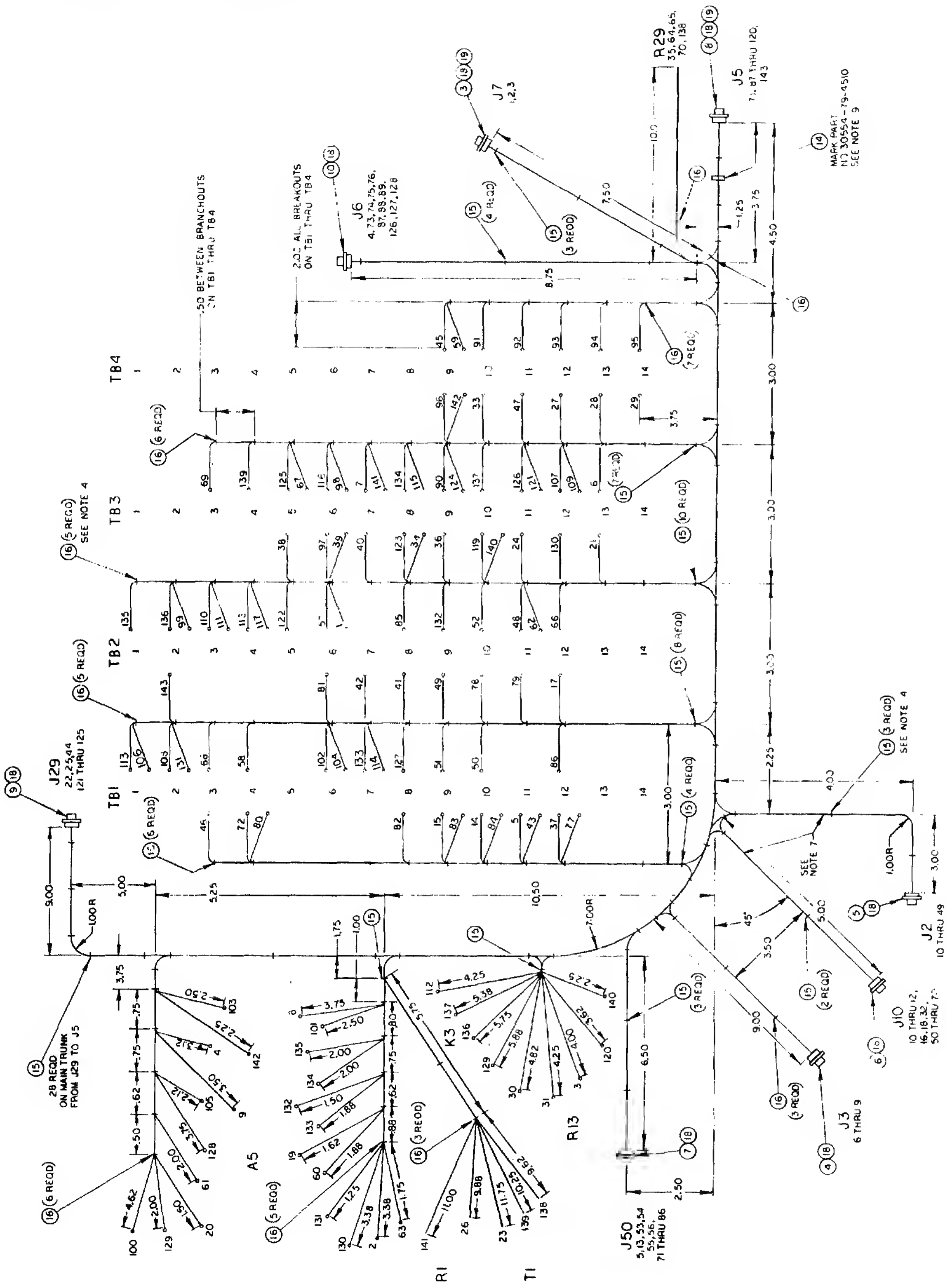


Figure 6-6. Mode I Relay Box Assembly A27, Wiring Harness (Sheet 1 of 4)

FIND NO	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO	QTY REQ	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
21		B	71-4924	6	TERMINAL, LUG, CRIMP STYLE		
20			MS25036-108	4	TERMINAL, LUG, CRIMP STYLE		
19			TYPE F FORM UA GRADE A. CL I CATEGORY I	7	TUBING INSULATION .166 ID X .020 WALL X .62 LG	MIL-I-631	
18			TYPE F FORM UA GRADE A. CL I CATEGORY I	155	TUBING INSULATION .106 X .016 WALL X .62 LG	MIL-I-631	
17			SN60WRAP2	AR	SOLDER, LEAD TIN ALLOY, ROSIN CORE	QQ-S-571	NOTE 3
16			MS3367-4-9	48	STRAP, TIEDOWN		NYLON
15			MS3367-1-9	74	STRAP, TIEDOWN		NYLON
14			MS39020-4	1	BAND, MARKER		AL ALY
13			MS25036-157	3	TERMINAL, LUG, CRIMP STYLE		
12			MS25036-111	2	TERMINAL, LUG, CRIMP STYLE		
11			MS25036-106	110	TERMINAL, LUG, CRIMP STYLE		
10			MS3102R20-27S	1	CONNECTOR, RECEPTACLE		
9			MS3102R22-19S	1	CONNECTOR, RECEPTACLE		
8			MS3102R36-7P	1	CONNECTOR, RECEPTACLE		
7			MS3102R28-12S	1	CONNECTOR, RECEPTACLE		
6			MS3102R32-7P	1	CONNECTOR, RECEPTACLE		
5			MS3102R36-7S	1	CONNECTOR, RECEPTACLE		
4			MS3102R14S-6S	1	CONNECTOR, RECEPTACLE		
3			MS3102R18-11S	1	CONNECTOR, RECEPTACLE		
2			M5086/2-12-9	AR	WIRE, ELECTRICAL	MIL-W-5086/2	
1			M5086/2-16-9	AR	WIRE ELECTRICAL	MIL-W-5086/2	

LIST OF MATERIAL

NOTES:
1. INTERPRET DRAWING PER MIL-STD-100.
2. ALL CONDUCTOR ENDS TO BE STRIPPED BACK 0.25 INCH AND TINNED BEFORE ASSEMBLY.
3. USE SOLDER FIND NO. 17 SOLDER CONNECTIONS PER MIL-STD-454, REQT 5.
4. CABLE STRAPS FIND NO. 15 AND 16 SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
5. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 INCHES.
6. A. TRUNK BENDS TO BE 2.00 RADIUS EXCEPT WHERE OTHERWISE SPECIFIED.
   B. BREAKOUTS TO BE 1.00 RADIUS.
7. FOR WIRING DIAGRAM SEE FO-6.
8. BRANCHOUTS TO FIND NO. 6 J10 AND FIND NO. 5 J2 SHALL BE LAID IN THAT RESPECTIVE ORDER.
9. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

Figure 6-6. Mode I Relay Box Assembly A27, Wiring Harness (Sheet 2 of 4)

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERMN FIND NO.	TO	TERMN FIND NO	LG REF
1	BLACK	P55PP12	J7-A	3	TB2-6	21	22.00
2	BLACK	P51A12	J7-B	3	A5-23	12	41.00
3	BLACK	P141D12	J7-E	3	R13-1	13	34.00
4	BLACK	P66B16	A5-3	11	J6-B	10	
5	BLACK	P6057A16	TB1-11	11	J50-E	7	19.85
6	BLACK	X91F16	J3-A	4	TB3-13	11	24.00
7	BLACK	X197E16	J3-B	4	TB3-7	11	28.00
8	BLACK	P42A16	J3-C	4	A5-14	11	23.50
9	BLACK	P67A16	J3-D	4	A5-2	11	31.00
10	BLACK	D20D16	J2-A	5	J10-J	6	13.50
11	BLACK	D21D16	J2-B		J10-H	6	13.50
12	BLACK	D22D16	J2-C		J10-G	6	13.50
13	BLACK	D24D16	J2-D		J50-d	7	21.00
14	BLACK	X7B16	J2-E		TB1-10	11	14.50
15	BLACK	X8B16	J2-F		TB1-9	11	15.00
16	BLACK	X14B16	J2-G		J10-a	6	13.50
17	BLACK	X15B16	J2-H		TB2-12	11	14.00
18	BLACK	X16B16	J2-I		J10-d	6	13.50
19	BLACK	L25C16	J2-J		A5-19	11	27.00
20	BLACK	L26C16	J2-K		A5-8	11	33.00
21	BLACK	X91C16	J2-L		TB3-13	11	17.00
22	BLACK	K31C16	J2-O		J29-C	9	41.00
23	BLACK	X194C16	J2-P		T1-2	—	38.50
24	BLACK	P45H16	J2-R		TB3-11	11	17.00
25	BLACK	X29C16	J2-S		J29-B	9	41.00
26	BLACK	X90D16	J2-U		R1-2	–	37.00
27	BLACK	E39C16	J2-V		TB4-12	11	19.50
28	BLACK	E38C16	J2-W		TB4-13	11	19.00
29	BLACK	E37C16	J2-X		TB4-14	11	18.50
30	BLACK	E35C16	J2-Y		R13-2	20	21.00
31	BLACK	E36C16	J2-Z		R13-3	20	20.50
32	BLACK	P199C16	J2-a		J10-f	6	13.50
33	BLACK	P198C16	J2-c		TB4-10	11	20.50
34	BLACK	P47D16	J2-e		TB3-8	11	17.50
35	BLACK	X195C16	J2-f		R29-3	—	28.50
36	BLACK	P44D16	J2-g		TB3-9	11	17.50
37	BLACK	P62B16	J2-h		TB1-12	11	13.50
38	BLACK	P56D16	J2-k		TB3-5	11	19.00
39	BLACK	P80C16	J2-m		TB3-6	11	18.50
40	BLACK	X197C16	J2-n		TB3-7	11	18.00
41	BLACK	P55ZZ16	J2-p		TB2-8	11	16.50
42	BLACK	P55W16	J2-r		TB2-7	11	17.00
43	BLACK	P57E16	J2-t		TB1-11	11	14.00
44	BLACK	P40K16	J2-u		J29-A	9	41.00
45	BLACK	P40J16	J2-v		TB4-9	11	24.00
46	BLACK	P50K16	J2-w		TB1-3	11	18.50
47	BLACK	P46C16	J2-x	5	TB4-11	11	20.00

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERMN FIND NO.	TO	TERMN FIND NO	LG REF
48	BLACK	X12B16	J2-y	5	TB2-11	11	16.50
49	BLACK	X9B16	J2-z	5	TB2-9	11	16.00
50	BLACK	X7A16	J10-A	6	TB1-10	11	16.00
51	BLACK	X8A16	J10-B		TB1-9	11	16.50
52	BLACK	X9A16	J10-C		TB2-10	11	18.50
53	BLACK	X19C16	J10-D		J50-V	7	18.50
54	BLACK	X18C16	J10-E		J50-U	7	19.00
55	BLACK	X17C16	J10-F		J50-T	7	19.00
56	BLACK	P63C16	J10-M		J50-d	7	19.00
57	BLACK	P55J16	J10-L		TB2-6	11	20.00
58	BLACK	P50EE16	J10-N		TB1-4	11	18.50
59	BLACK	P40AB16	J10-V		TB4-9	11	30.00
60	BLACK	X21R16	J10-S		A5-20	11	25.50
61	BLACK	X22R16	J10-T		A5-7	11	33.50
62	BLACK	X12W16	J10-W		TB2-11	11	17.50
63	BLACK	X6C16	J10-X		A5-22	11	26.00
64	BLACK	X194E16	J10-Y		R29-1	—	29.00
65	BLACK	X195D16	J10-Z		R29-3	—	29.00
66	BLACK	X15A16	J10-b		TB2-12	11	18.00
67	BLACK	P56H16	J10-c		TB3-5	11	23.00
68	BLACK	P50MM16	J10-e		TB1-3	11	19.00
69	BLACK	X98C16	J10-h		TB3-3	11	23.50
70	BLACK	X97A16	J10-i	6	R29-2	—	32.00
71	BLACK	P58B16	J50-A	7	J5-E	8	28.00
72	BLACK	P50R16	J50-B		TB1-4	11	20.00
73	BLACK	P206B16	J50-C		J6-1	10	36.00
74	BLACK	P205B16	J50-D		J6-H	10	36.00
75	BLACK	P203B16	J50-F		J6-F	10	36.00
76	BLACK	P209B16	J50-G		J6-M	10	36.00
77	BLACK	P62H16	J50-H		TB1-12	11	16.50
78	BLACK	X9T16	J50-J		TB2-10	11	21.50
79	BLACK	X12AA16	J50-K		TB2-11	11	21.50
80	BLACK	P50Z16	J50-L		TB1-4	11	19.00
81	BLACK	P55Y16	J50-M		TB2-6	11	23.50
82	BLACK	P200S16	J50-P		TB1-8	11	18.00
83	BLACK	X8H16	J50-R		TB1-9	11	17.00
84	BLACK	X7H16	J50-S		TB1-10	11	16.50
85	BLACK	P55AR16	J50-W		TB2-8	11	25.00
86	BLACK	P62A16	J50-b	7	TB1-12	11	21.00
87	BLACK	P207B16	J5-A	8	J6-K	10	15.00
88	BLACK	P202B16	J5-B		J6-E	10	15.00
89	BLACK	P201B16	J5-C		J6-D	10	15.00
90	BLACK	P44H16	J5-D		TB3-9	11	14.00
91	BLACK	P198E16	J5-G		TB4-10	11	10.50
92	BLACK	P46E16	J5-H		TB4-11	11	10.00
93	BLACK	E39E16	J5-I		TB4-12	11	9.50
94	BLACK	E38E16	J5-J	8	TB4-13	11	8.50

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

Figure 6-6. Mode I Relay Box Assembly A27, Wiring Harness (Sheet 3 of 4)

WIRE NO	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERMN FIND NO	TO	TERMN FIND NO	LG REF
95	BLACK	E37E16	J5-K	8	TB4-14	11	7.50
96	BLACK	P40H16	TB4-9		J5-M	11	15.75
97	BLACK	P80B16	J5-P		TB3-6	11	17.50
98	BLACK	P80F16	J5-R		TB3-6	11	17.50
99	BLACK	P55F16	J5-S		TB2-2	11	18.50
100	BLACK	P48B16	J5-U		A5-12	11	43.00
101	BLACK	P54B16	J5-V		A5-13	11	33.00
102	BLACK	P200J16	J5-W		TB1-6	11	20.50
103	BLACK	P52B16	J5-Y		A5-4	11	40.00
104	BLACK	P200L16	J5-Z		TB1-6	11	21.00
105	BLACK	P68B16	J5-b		A5-6	11	42.00
106	BLACK	P50X16	J5-c		TB1-1	11	23.00
107	BLACK	P51D16	J5-d		TB3-12	11	13.00
108	BLACK	P50U16	J5-e		TB1-2	11	23.00
109	BLACK	P51F16	J5-f		TB3-12	11	13.00
110	BLACK	P55S16	J5-g		TB2-3	11	18.25
111	BLACK	P55P16	J5-h		TB2-3	11	18.50
112	BLACK	P41A16	J5-j		K3-A1	20	30.00
113	BLACK	P50KK16	J5-k		TB1-1	11	23.00
114	BLACK	P200P16	J5-m		TB1-7	11	20.50
115	BLACK	P47J16	J5-n		TB3-8	11	14.00
116	BLACK	P80A16	J5-p		TB3-6	11	15.00
117	BLACK	P55M12	J5-t		TB2-4	21	18.00
118	BLACK	P55E12	J5-u		TB2-4	21	18.00
119	BLACK	P140E12	J5-w		TB3-10	21	15.00
120	BLACK	P141C12	J5-z	8	R13-1	13	31.00
121	BLACK	P45L16	J29-D	9	TB3-11	11	47.00
122	BLACK	P55UU16	J29-E	9	TB2-5	11	48.00
123	BLACK	P47F16	J29-F	9	TB3-8	11	47.00
124	BLACK	P44E16	J29-G	9	TB3-9	11	49.00
125	BLACK	P56E16	J29-H	9	TB3-5	11	51.00
126	BLACK	P45J16	J6-A	10	TB3-11	11	20.00
127	BLACK	P200B16	J6-C	10	TB1-8	11	27.00
128	BLACK	P208B16	J6-L	10	A5-5	11	48.50
129	BLACK	P49A16	A5-9	11	K3-X2	11	24.50
130	BLACK	P51C16	A5-24	11	TB3-12	11	30.00
131	BLACK	P50JJ12	A5-21	12	TB1-2	21	30.50
132	BLACK	X9J16	A5-18	11	TB2-9	11	29.50
133	BLACK	P200N16	A5-17	11	TB1-7	11	28.00
134	BLACK	P47E16	A5-16	11	TB3-8	11	32.00
135	BLACK	P55U16	A5-15	11	TB2-1	11	32.50
136	BLACK	P55YY16	K3-X1	11	TB2-2	11	30.00
137	BLACK	P140H16	K3-A2	20	TB3-10	11	29.00
138	BLACK	X194D16	T1-2	—	R29-1	—	53.00
139	BLACK	X96A16	T1-1	—	TB3-4	11	46.50
140	BLACK	P140F12	R13-4	13	TB3-10	21	23.00
141	BLACK	X197D16	TB3-7	11	R1-1	—	46.00
142	BLACK	P40AA16	TB4-9	11	A5-1	11	44.00
143	BLACK	P55BK16	J5-O	8	TB2-2	11	26.00

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

Figure 6-6. Mode I Relay Box Assembly A27, Wiring Harness (Sheet 4 of 4)

Section III. MAINTENANCE OF EXCITER-REGULATOR A11

6-13. GENERAL. Exciter-regulator A11 operates to maintain the generator set output despite variations of the load circuits. The exciter portion of exciter regulator A11 provides the dc source voltage necessary to energize the exciter field while voltage regulator A10 controls this voltage to maintain a relatively constant generator set output (refer to the Operator and Organizational Maintenance Manual for exciter-regulator theory of operation).

6-14. INSPECTION.

a. Inspect exciter-regulator A1 for cracks, dents, or other damage or deformity of housing.

b. Check security of mounting and mounting hardware.

c. Inspect for loose or broken electrical connections and for frayed wires.

6-15. ON-EQUIPMENT TEST. To test exciter-regulator A11 proceed as follows:

a. Shut down generator set.

b. Remove connectors P13 and P9 from exciter-regulator A11.

c. Connect a variable dc power supply (0 to 10 volts at 15 amperes with a built-in ammeter) in series with connector P13 pin R (positive) and pin S (negative). Set dc power supply for a zero output.

d. Start generator set and allow engine sufficient time to warm up before proceeding to next step.

e. Adjust dc power supply for the rated generator set ouput (120/208 or 240/416). DC ammeter (part of power supply) should read between 3 to 3.5 amperes. If normal readings are obtained, exciter-regulator A11 is probably defective. If abnormal readings are obtained, generator G1 is probably defective (refer to Chapter 10 of this manual).

f. Shut down generator set and disconnect dc power supply.

g. Reconnect connectors P9 and P13.

6-16. REMOVAL. To remove exciter-regulator A11 from the generator set, refer to figure 2-2 and proceed as follows:

NOTE

If it is required to remove the voltage regulator proceed to step d.

a. Disconnect plugs P13 and P9 from side of A11.

b. Remove four screws and nuts securing exciter-regulator A11 in position.

c. Remove exciter-regulator from generator set.

d. Remove eight screw assemblies (1, figure 6-9) that secure cover (2) to chassis (46).

e. Disconnect plug P11 that connects exciter A11 to voltage regulator A10.

f. Remove four screw assemblies (3) that secure voltage regulator A10 to chassis (46) and remove A10.

6-17. TEST (Voltage Regulator A10).

a. Test exciter portion of exciter-regulator A11, proceed as follows:

(1) Connect exciter A11 to test equipment as shown in figure 6-7.

(2) Set test switches to open.

(3) Perform tests specified in procedural analysis table 6-4.

(4) Deenergize and disconnect test setup of figure 6-7.

b. To test voltage regulator A10, proceed as follows:

(1) Connect voltage regulator A10 to test equipment shown in figure 6-8.

NOTE

The particular exciter being used in this test setup may be assumed to be in good working order (having been tested as described above).

(2) Set all test switches to open.

(3) Perform tests specified in procedural analysis table 6-5.

(3) Deenergize and disconnect test setup of figure 6-8.

6-18. DISASSEMBLY. To disassemble exciter-regulator A11 refer to figures 6-9, 6-10, and 6-11, and proceed as follows:

NOTE

The exciter-regulator A11 shall be disassembled only to the extent necessary to affect its repair.

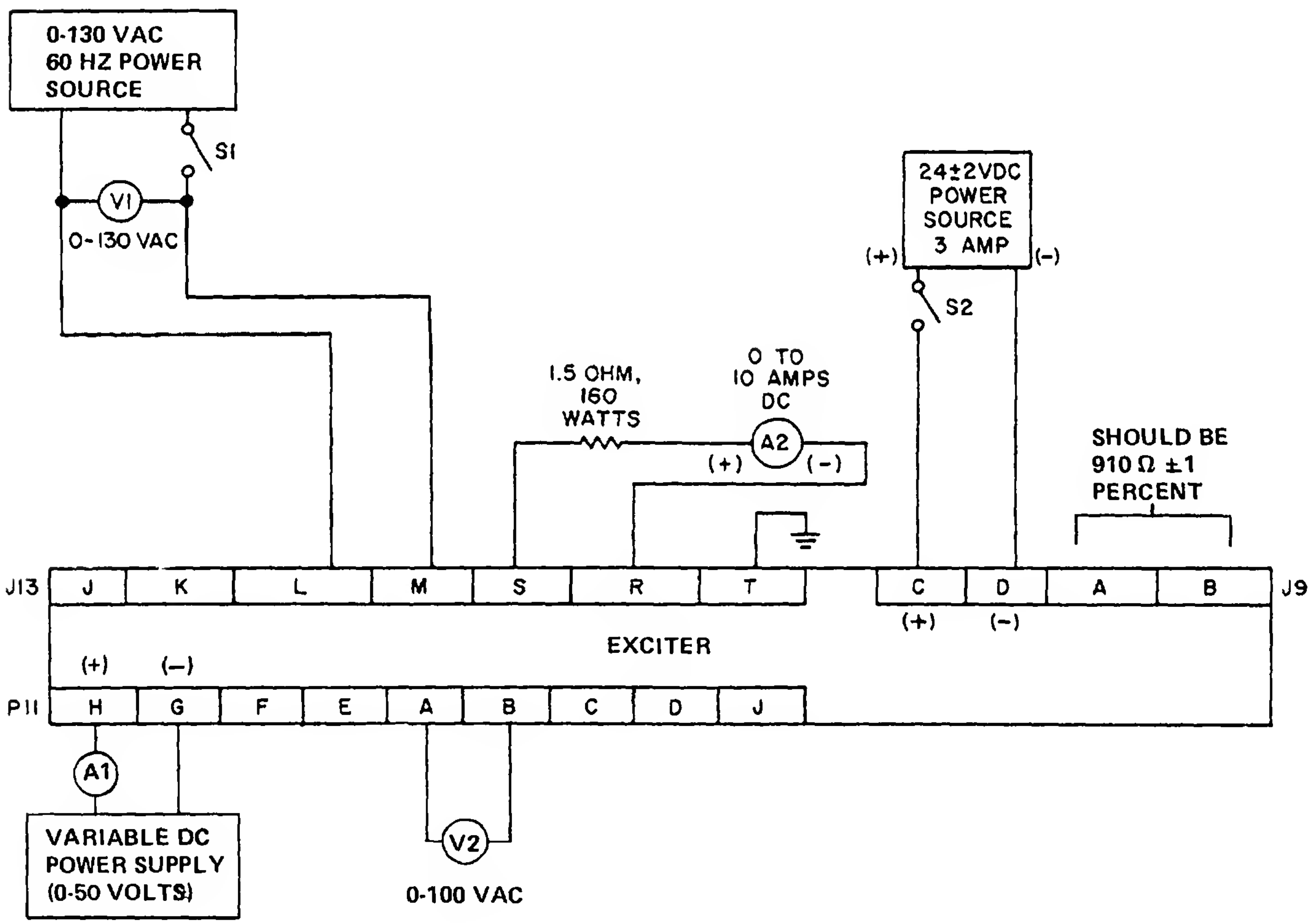


Figure 6-7. Exciter, Test Setup

Table 6-4. Exciter Procedural Analysis

STEP	TEST CONDITION	REQUIRED RESULT	PROBABLE CAUSE FOR IMPROPER RESULT	CHECK OUT PROCEDURE
1.	Energize 24 V dc power source. Close switch S2.	Ammeter A2 should indicate approximately 2 amperes.	Defective component in field flashing circuit.	Check resistors R17A, R17B, diode CR16, and bridge CR1-4.
2.	Open switch S2. Energize variable 60 Hz power source, close switch S1 and adjust so V1 reads 120 volts. Adjust variable DC power supply (approximately 38 V dc) so that A1 reads 0.	A2 should read 4.8 amperes.	Open reactor L1. Defective transformer T1. Shorted or open diode in bridge CR1-4.	Make continuity check of L1 and T1. Check diodes CR1-4. Replace where necessary.
3.	Readjust variable DC power supply so that A1 reads 1.9 amperes.	A2 should read approximately .45 amperes.	Defective bridge CR1-4, L1, or T1.	Check CR1-4, L1, or T1. Replace where necessary.
4.	Observe voltmeter V2.	V2 should read 50 V ac minimum.	Defective transformer T4.	Check T4. Replace if necessary.
5.	Using multimeter, check resistance across terminals A and B of J9.	Reading should be 910 ohms, ±1 percent.	Defective resistor R1.	Replace resistor if defective.

Table 6-5. Regulator, Procedural Analysis

STEP	TEST CONDITION	REQUIRED RESULT	PROBABLE CAUSE FOR IMPROPER RESULT	CHECK OUT PROCEDURE
1.	Energize 60 Hz power source, close switch S1 and adjust so V1 reads 120 volts. Adjust R1 of test setup so that A1 reads 0.	A2 should read 4.8 amperes.	Regulator A10 defective if either adjustment cannot be made or A2 reading is incorrect.	See step 4. of this table for regulator A10 troubleshooting procedures.
2.	Readjust R1 so that A1 reads 1.9 amperes.	A2 should read approximately .45 amperes.	Regulator A10 defective if either adjustment cannot be made or A2 reading is incorrect.	See step 4. of this table for regulator troubleshooting procedures.
3.	Set R1 to zero ohms. Adjust voltage at V1 until A1 begins to increase from 0. Refer to exciter-regulator schematic diagram in the Operator and Organizational Maintenance Manual. With power input at 120 V ac adjust R1 so that A1 reads 0.	The increase at A1 should occur when V1 equals 104 V ac.	Range pot R33 improperly adjusted.	Reset pot R33 so that A3 begins increase at 104 V ac. If R33 cannot be reset, see step 4. of this table for regulator troubleshooting procedures.

Table 6-5. Regulator, Procedural Analysis (Continued)

STEP	TEST CONDITION	REQUIRED RESULT	PROBABLE CAUSE FOR IMPROPER RESULT	CHECK OUT PROCEDURE
4.	Measure voltage between the following points in exciter-regulator schematic diagram in the Operator and Organizational Maintenance Manual.			
	From (-) to (+)			
	a. TB1-2 to TB1-1	a. 17 volts.	a. Defective T5, CR12-15, R16, R1, R2, C2, and C5.	a. Check T5 for shorted or open windings, check diodes in bridge. Check for open resistors or shorted capacitors.
	b. TB1-2 to TB1-6	b. 50 volts.	b. Defective T4, CR8-11.	b. Check diodes in bridge. Check T4 windings for opens or shorts.
	c. TB1-2 to TB1-3	c. 0 volts.	c. Defective Q1-Q2, R3, R4, R5, R6, R7, R8, C4, VR1.	c. Check and replace Q2, C4. Check resistor for proper value and opens.
	d. TB1-2 to Q5-C	d. 8.2 volts.	d. Defective Q5 or Q6. Incorrect value R8, R9, R18, R19, R20.	d. Check and replace transistors where necessary. Check resistor values.
	e. TB1-2 to TB2-8	e. 50 volts.	e. Defective Q3, Q4, R9 or CR17.	e. Check and replace transistors where necessary. Check resistor and diode.

Table 6-5. Regulator, Procedural Analysis (Continued)

STEP	TEST CONDITION	REQUIRED RESULT	PROBABLE CAUSE FOR IMPROPER RESULT	CHECK OUT PROCEDURE
	f. Q1-B to TB2-1	f. 5 volts	f. Defective VR1	f. Check and replace if necessary.
5.	Readjust R1 so that A3 reads 2.4 amperes maximum and measure the voltage between the same points as follows:	(Check for shorted CR7 if A3 will not read 2.4 amperes.)		
	From (-) to (+)			
	a. TB1-2 to TB1-1	a. 19.8 volts.	a. See 4a.	a. See 4a.
	b. TB1-2 to TB1-6	b. 50 volts.	b. See 4a.	b. See 4a.
	c. TB1-2 to TB1-3	c. 2.6 volts.	c. Shorted C4. See 4c.	c. Check and replace C4. See 4c.
	d. TB1-2 to Q5-C	d. 2 volts.	d. Shorted or open CR17. See 4d.	d. Check and replace CR17. See 4d.
	e. TB1-2 to TB2-8	e. 1 volt.	e. See 4e.	e. See 4e.
	f. Q1-B to TB2-1	f. 5 volts.	f. See 4f.	f. See 4f.

Table 6-5. Regulator, Procedural Analysis (Continued)

STEP	TEST CONDITION	REQUIRED RESULT	PROBABLE CAUSE FOR IMPROPER RESULT	CHECK OUT PROCEDURE

NOTES:
1. All voltages in steps 4. and 5. above are ±20 percent.
2. To reach test point EE, remove screws holding printed circuit board and test from below board.
3. If regulation is unsatisfactory after check-out, recheck CR17 for open or short and R21 for correct value.
4. If stability is unsatisfactory, check R14, R31, R32 for correct values and C1, C3 for opens or shorts.

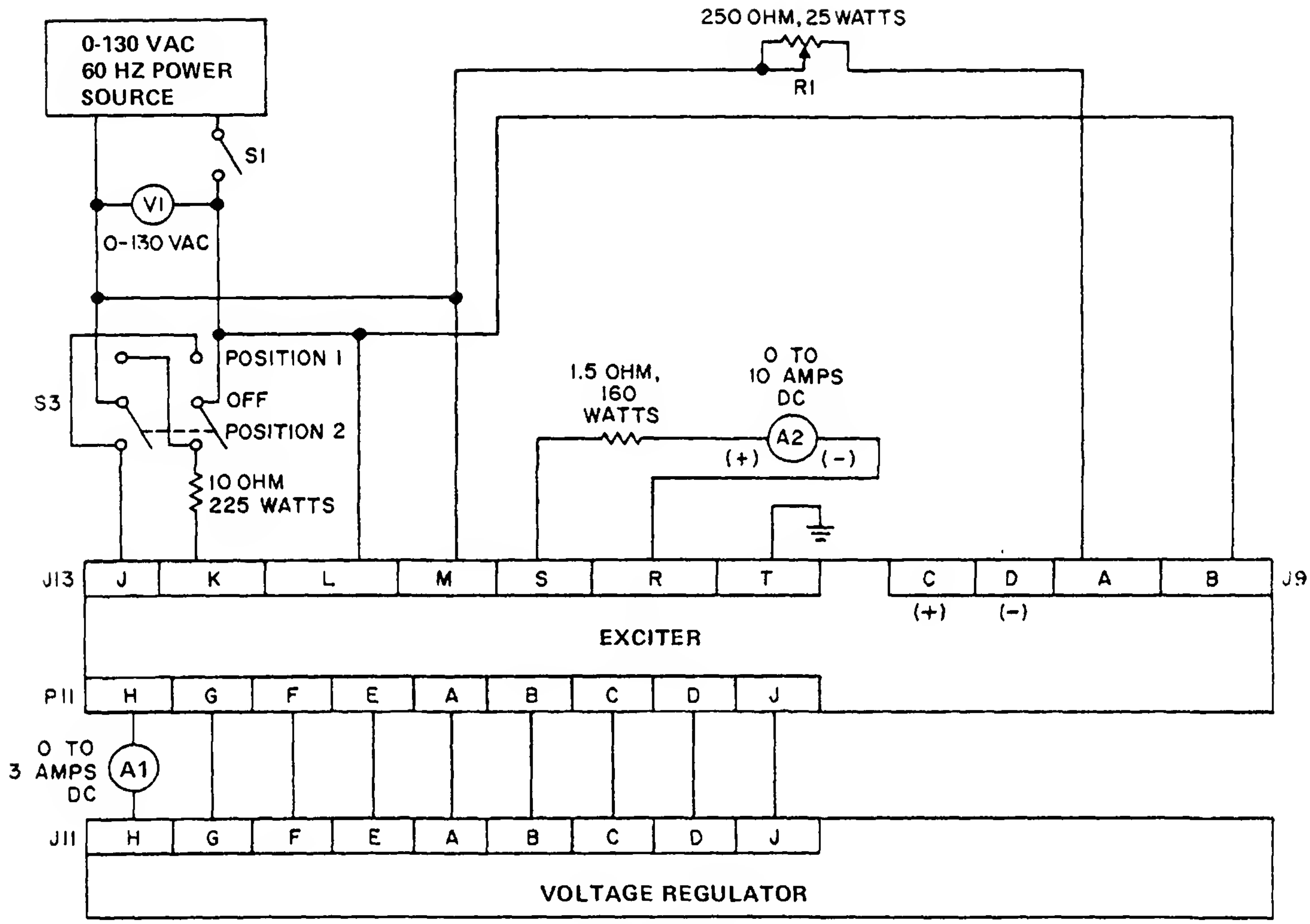


Figure 6-8. Regulator, Test Setup

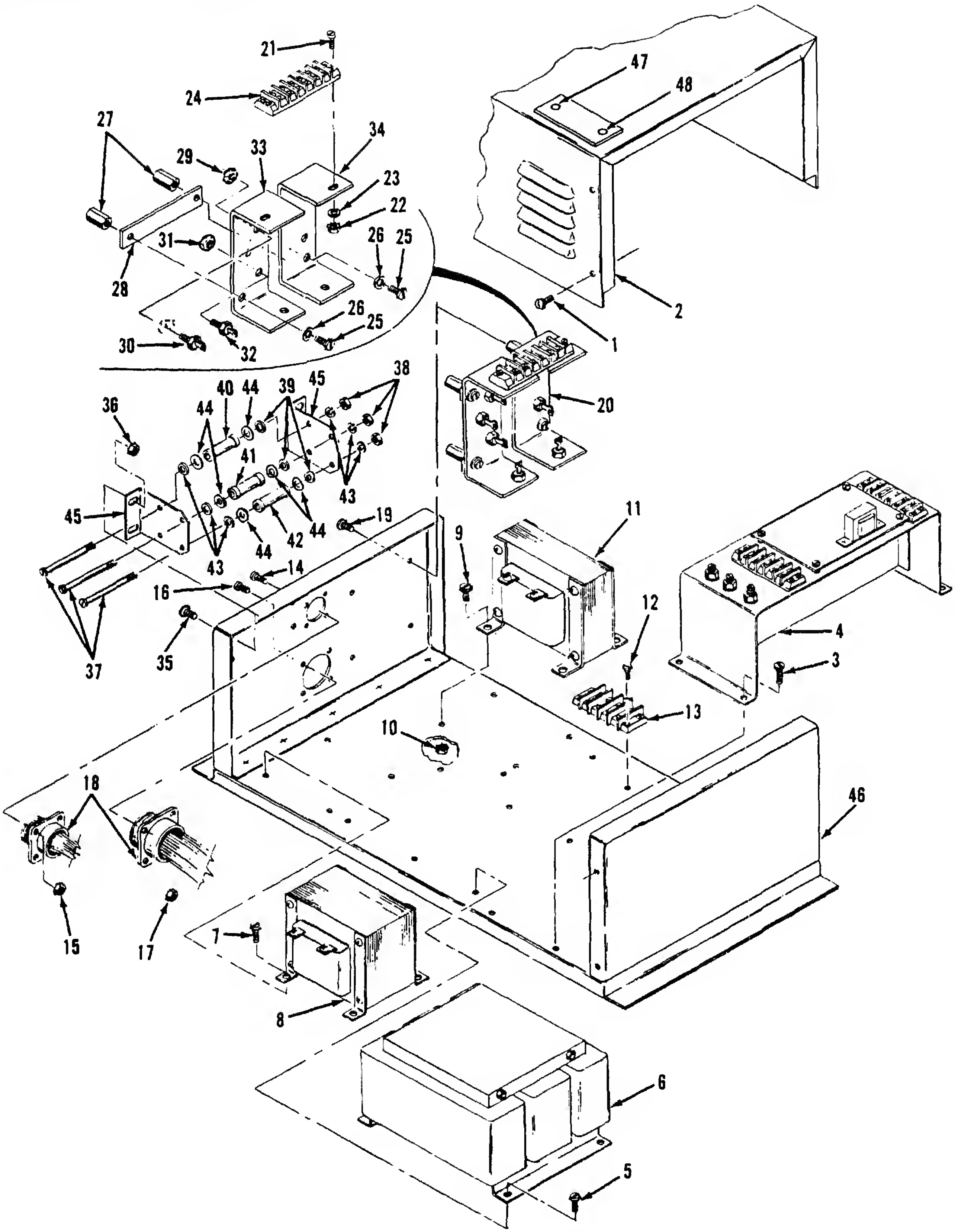


Figure 6-9. Exciter-Regulator, A11, Exploded View (Sheet 1 of 2)

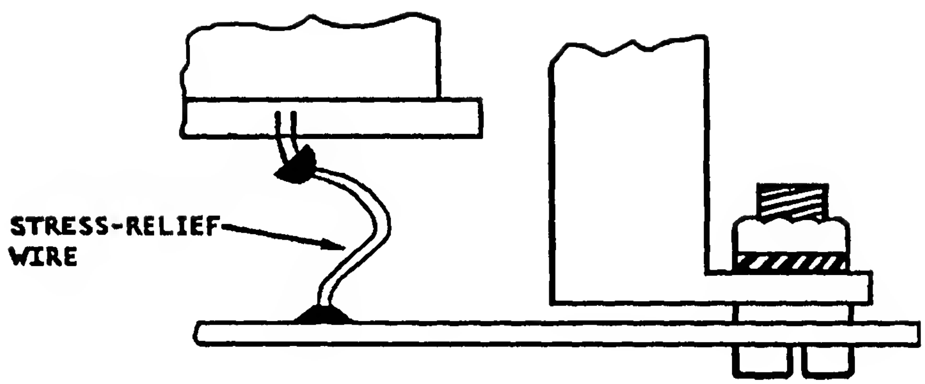


Figure 6-9.1

1. SCREW ASSY
2. COVER
3. SCREW ASSY
4. VOLTAGE REGULATOR ASSY (A10)
5. SCREW ASSY
6. TRANSFORMER (T1)
7. SCREW ASSY
8. CONTROL TRANSFORMER (T4)
9. SCREW ASSY
10. NUT ASSY
11. REACTOR (L1)
12. SCREW ASSY
13. TERMINAL BOARD
14. SCREW ASSY
15. NUT ASSY
16. SCREW ASSY
17. NUT ASSY
18. WIRING HARNESS
19. SCREW ASSY
20. BRIDGE RECTIFIER ASSY (CR1-4)
21. SCREW
22. NUT ASSY
23. WASHFR
24. TERMINAL BOARD
25. SCREW
26. STANDOFF
27. SHOULDER WASHER
28. INSULATED PLATE
29. NUT
30. RECTIFIER DIODE
31. NUT
32. RECTIFIER DIODE
33. HEATSHIELD DIODE
34. HEATSHIELD DIODE
35. SCREW ASSY
36. NUT ASSY
37. SCREW
38. NUT
39. LOCKWASHER
40. RESISTOR
41. RESISTOR
42. RESISTOR
43. MICA WASHER
44. WASHER
45. BRACKET
46. CHASSIS

Figure 6-9. Exciter-Regulator, A11, Exploded View (Sheet 2 of 2)

a. Remove cover (2, figure 6-9) by removing eight screw assemblies (1).

b. Tag leads prior to disconnecting them. Note polarity and locations of components when tagging.

c. Exercise care not to apply excessive heat when unsoldering components. Use heat sinks while unsoldering solid-state components.

d. To remove voltage regulator, remove four screw assemblies (3) and disconnect plug P11.

e. To remove components from voltage regulator refer to figure 6-10.

f. To remove components from voltage regulator subassembly refer to figure 6-11.

WARNING

Cleaning solvent trichloroethane (Tri-ethane) 1.1.1 (MIL-T-81533A) is flammable and toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory tract protection is required.

del

~~6-19. CLEANING. Clean all components with a clean lint-free cloth moistened with cleaning solvent (tri-ethane 1.1.1 MIL-T-81533A) and dry thoroughly.~~

incl. see OS-1

6-20. INSPECTION. To inspect exciter-regulator A11 proceed as follows:

a. Inspect wiring harnesses for defective insulation and loose connections.

b. Inspect harness connectors for damaged threads and for bent, loose, or missing pins.

c. Check electrical components for signs of overheating and signs of obvious damage.

d. Check diodes for forward and reverse resistance. Forward resistance should be relatively low whereas reverse resistance should be at least 100 times greater than forward resistance.

e. Inspect printed circuit boards (component side) for loose or missing foil, signs of overheating (discoloration) and for other signs of obvious damage.

f. Inspect all connections for signs of cold solder joints.

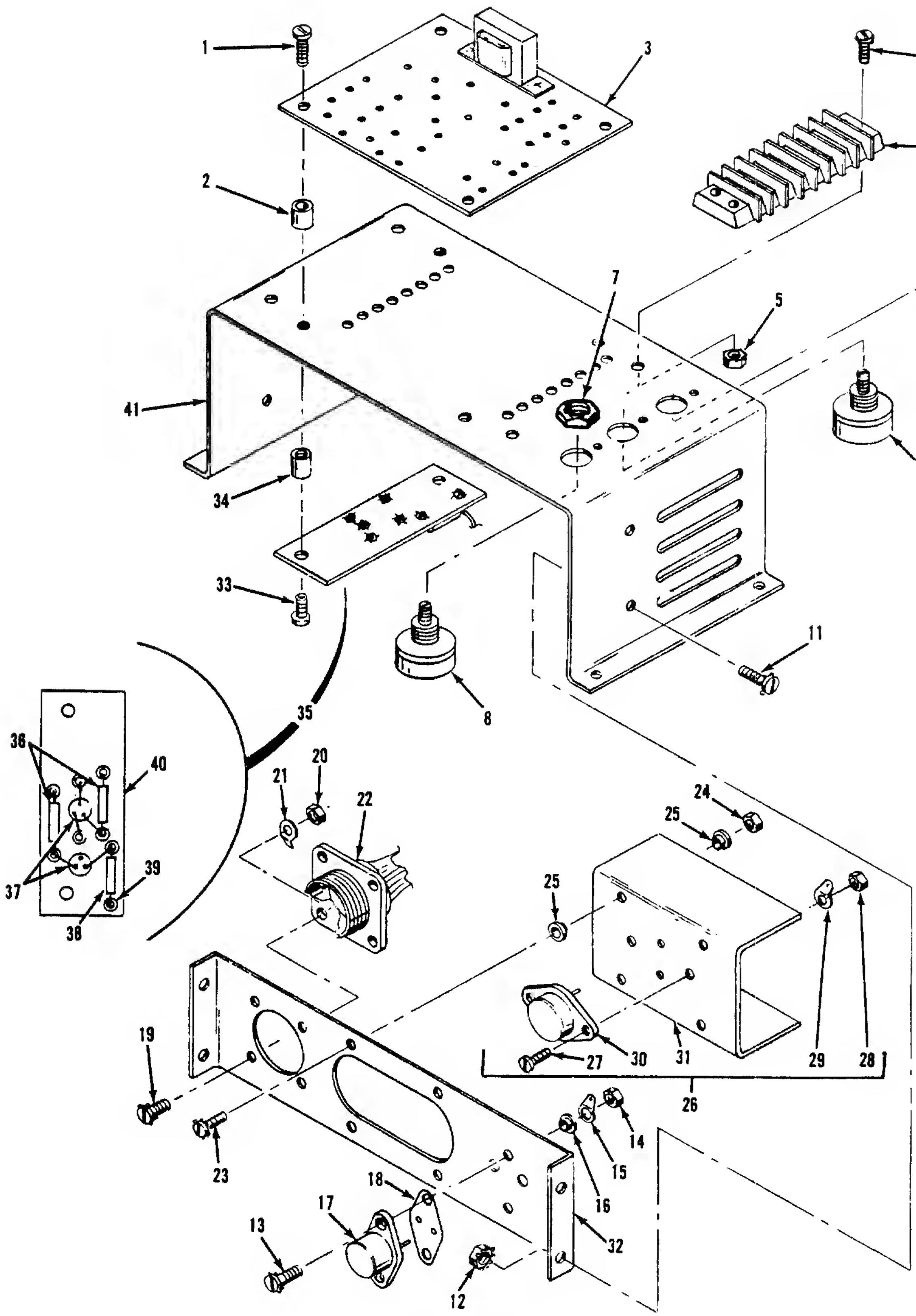


Figure 6-10. Voltage Regulator, Exploded View (Sheet 1 of 2)

1. SCREW ASSY
2. STANDOFF
3. VOLTAGE REGULATOR
4. SCREW ASSY
5. NUT ASSY
6. TERMINAL BOARD
7. NUT
8. VARIABLE RESISTOR
9. VARIABLE RESISTOR
10. VARIABLE RESISTOR
11. SCREW ASSY
12. NUT ASSY
13. SCREW ASSY
14. SELF-LOCKING NUT
15. TERMINAL LUG
16. SHOULDER WASHER
17. TRANSISTOR
18. MICA WASHER
19. SCREW ASSY
20. NUT ASSY
21. TERMINAL LUG
22. WIRING HARNESS
23. SCREW ASSY
24. SELF-LOCKING NUT
25. SHOULDER WASHER
26. HEATSINK ASSY
27. SCREW ASSY
28. SELF-LOCKING NUT
29. TERMINAL LUG
30. TRANSISTOR
31. HEATSINK
32. BRACKET
33. SCREW ASSY
34. STANDOFF
35. COMPONENT BOARD ASSY
36. RESISTOR
37. TRANSISTOR
38. RESISTOR
39. EYELET
40. COMPONENT BOARD
41. CHASSIS ASSY

Figure 6-10. Voltage Regulator, Exploded View (Sheet 2 of 2)

g. Inspect sheet metal parts for bent corners, distortion, cracks, tears, and dents.

6-21. REPAIR. Repair of the exciter-regulator A11 consists mostly of replacing defective parts. Additional repair procedures are as follows:

a. Cut back any loose printed circuit board foil to a point where foil is secured to board. Carefully scrape away insulation coating at point where foil has just been cut.

b. Using size 22 gage insulated wire of correct length and stripped at both ends, solder this wire into place of removed foil. Tape wire against board and make certain that no solder bridges have occurred where wire has been soldered.

WARNING

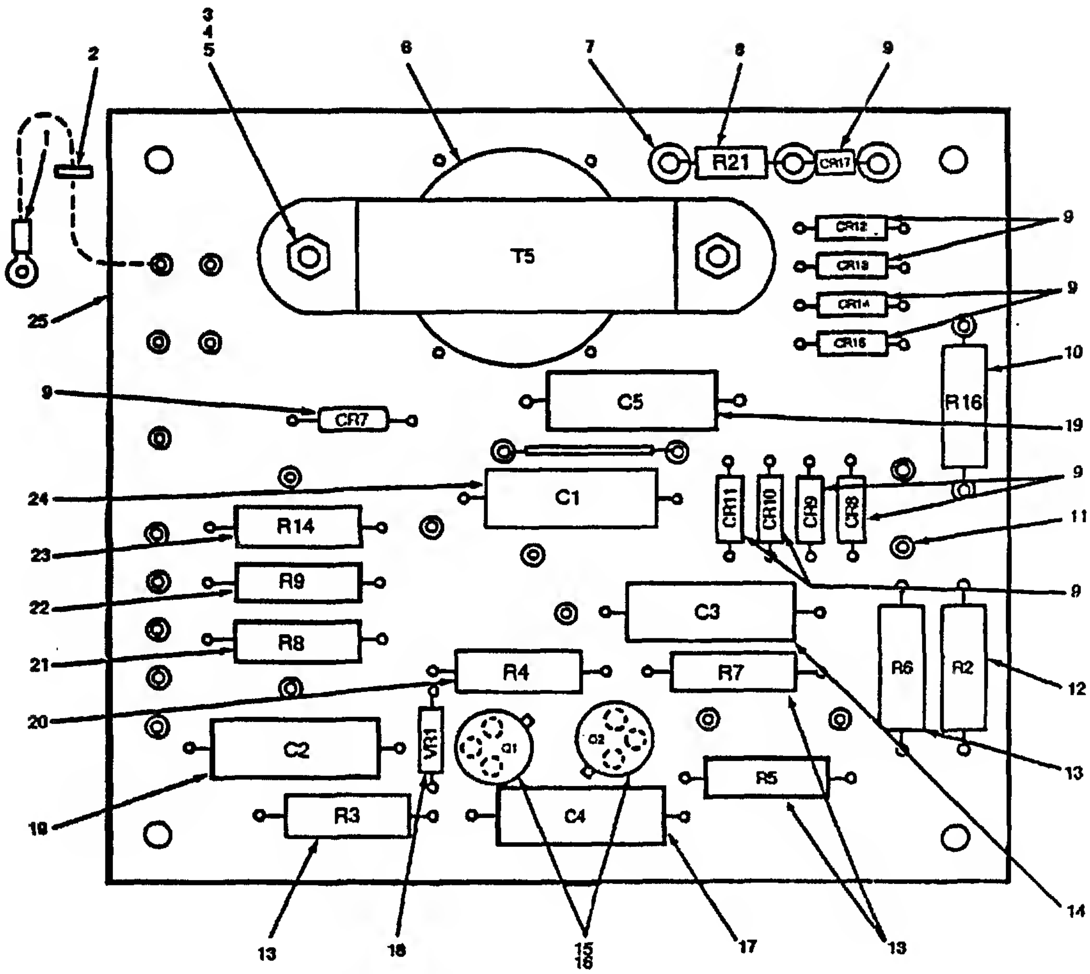
Paint is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

c. Straighten dented or distorted sheet metal parts using proper tools. Blend in repaired area with fine abrasive paper. Prime and touch up damaged surfaces using olive drab, per MIL-T-704, Type A, semi-gloss, No. X24087.

d. Broken T5 transformer leads can be repaired by soldering a 1.5 inch long, MIL-W-16878/2C 18 AWG stranded, stress-relief wire from the transformer's broken lead to its soldering terminal on the board. (See Figure 6-9.1. Exciter Regulator, Transformer Lead Repair).

6-22. REBUILD. Rebuild exciter regulator A11 wiring harnesses according to figure 6-12 and 6-13 and paragraph 6-66.

6-23. REASSEMBLY. To reassemble exciter regulator A11 refer to figures 6-9, 6-10, and 6-11, and proceed as follows:



1. TERMINAL LUG
2. CABLE STRAP
3. SCREW ASSY
4. NUT ASSY
5. WASHER
6. TRANSFORMER
7. EYELET
8. RESISTOR
9. DIODE
10. RESISTOR
11. EYELET
12. RESISTOR
13. RESISTOR
14. CAPACITOR
15. TRANSISTOR
16. TRANSISTOR PAD
17. CAPACITOR
18. DIODE
19. CAPACITOR
20. RESISTOR
21. RESISTOR
22. RESISTOR
23. RESISTOR
24. CAPACITOR
25. PRINTED CIRCUIT BOARD

Figure 6-11. Voltage Regulator, Subassembly

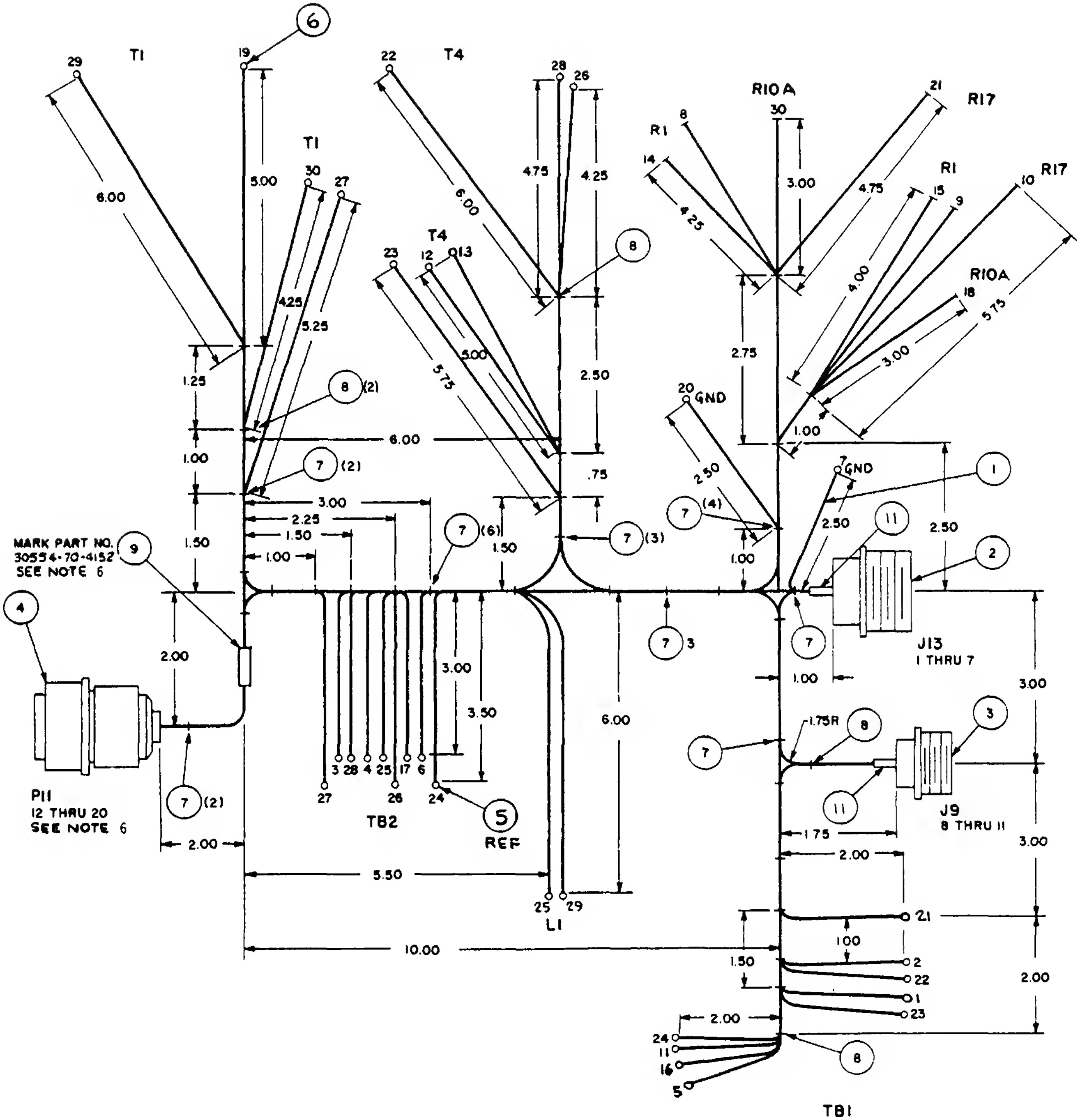


Figure 6-12. Exciter-Regulator A11, Wiring Harness (Sheet 1 of 2)

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERMN FIND NO.	TO	TERMN FIND NO.	LG REF
1	BLACK	U134C16	J13-J	—	TB1-3	5	10.50
2	BLACK	U135C16	J13-K	—	TB1-2	5	10.50
3	BLACK	X9EE16	J13-L	—	TB2-3	5	13.50
4	BLACK	X12TT16	J13-M	—	TB2-2	5	13.00
5	RED	P73B16	J13-R	—	TB1-5	5	11.00
6	RED	P67D16	J13-S	—	TB2-1	5	12.00
7	RED	P55AK16	J13-T	—	GND	6	4.00
8	BLACK	X91E16	J9-A	—	R1-1	-	14.50
9	BLACK	X197H16	J9-B	—	R1-2	-	12.50
10	RED	P42C16	J9-C	—	R17A-2	-	14.50
11	RED	P67C16	J9-D	—	TB1-6	5	9.00
12	BLACK	X146A16	P11-A	—	T4-3	6	18.25
13	BLACK	X147A16	P11-B	—	T4-4	6	18.25
14	BLACK	X91H16	P11-C	—	R1-1	-	24.00
15	BLACK	X197J16	P11-D	—	R1-2	-	22.00

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERMN FIND NO.	TO	TERMN FIND NO.	LG REF
16	RED	P73E16	P11-E	—	TB1-5	5	24.00
17	RED	P67H16	P11-F	—	TB2-1	5	10.25
18	BLACK	V159A16	P11-G	—	R10A-2	-	22.00
19	BLACK	V160A16	P11-H	—	T1-5	6	13.75
20	RED	P55AJ16	P11-J	—	GND	6	18.50
21	RED	P72A16	TB1-1	5	R17A-1	-	16.25
22	BLACK	U135D16	TB1-2	5	T1-3	6	24.75
23	BLACK	U134D16	TB1-3	5	T1-4	6	20.00
24	RED	P67J16	TB1-6	5	TB2-1	5	20.50
25	BLACK	X12UU16	TB2-2	5	L1-2	6	12.75
26	BLACK	X12WW16	TB2-2	5	T4-1	6	18.00
27	BLACK	X9FF16	TB2-3	5	T1-2	6	11.25
28	BLACK	X96616	TB2-3	5	T4-2	6	17.00
29	BLACK	X154A16	L1-1	6	T1-1	6	21.75
30	BLACK	X153A16	T1-7	6	R10A-1	-	26.00

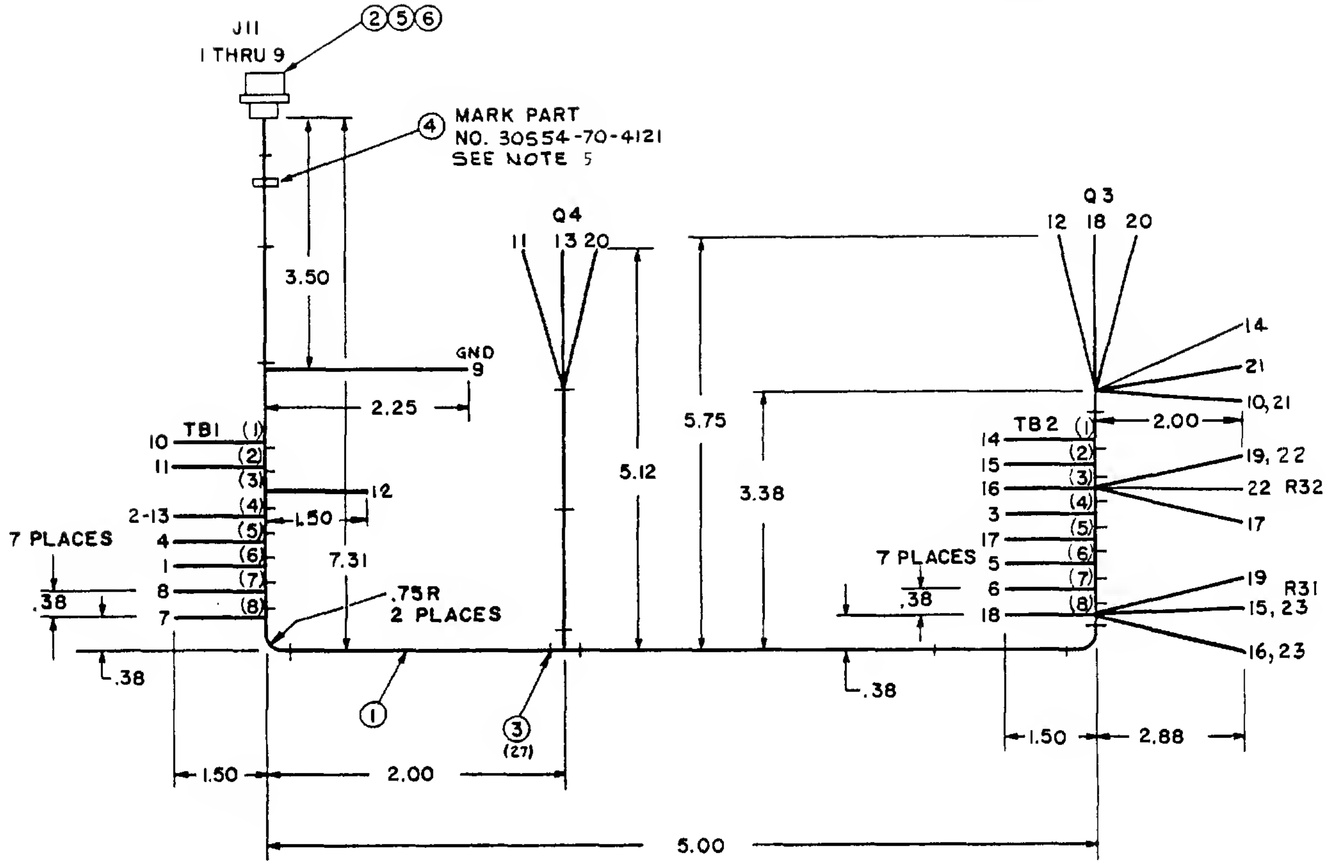
FIND NO	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
11			Type F, Form U Grade A, Cl I Category 1	11	Tubing Insulation .106 ID X .020 Wall X .62 Lg	MIL-I-631	
10			SN60WRAP2	AR	Solder, Lead-Tin Alloy Rosin Core	QQ-S-571	NOTE 2
9			MS39020-2	1	Band, Marker		AL ALY
8			MS3367-4-9	5	Strap, TIEDOWN		NYLON
7			MS3367-1-9	28	Strap, TIEDOWN		NYLON
6			MS25036-108	14	Terminal, Lug, Crimp Style		
5			MS25036-106	18	Terminal, Lug, Crimp Style		
4			MS3106R18-1P	1	Connector, Plug		
3			MS3102R14S-6P	1	Connector, Receptacle		
2			MS3102R22-14P	1	Connector, Receptacle		
1			M5086/2-16-9	AR	Wire, Electrical	MIL-W-5086/2	

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE FIND NO. 10 AND SOLDER.
3. CABLE STRAPS, FIND NO'S 7 AND 8, SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
4. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
5. A. TRUNK BENDS TO BE 1.00 RADIUS EXCEPT WHERE OTHERWISE SPECIFIED.
   B. BREAKOUTS TO BE .50 RADIUS.
6. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

Figure 6-12. Exciter-Regulator A11, Wiring Harness (Sheet 2 of 2)



NOTES:

1. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
2. USE SOLDER, FIND NO. 5.
3. CABLE STRAPS, FIND NO. 3, SHALL BE SPACED AT APPROX. 1.50 APART UNLESS OTHERWISE SPECIFIED.
4. SOLDER.
5. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.
6. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 INCHES

WIRE NO.	IDENTIFICATION COLOR	NUMBER	FROM	TERMN FIND NO.	TO	TERMN FIND NO.	LG REF
1	RED	00496 -0378	J11-G	SOLDER	TB1-6	SOLDER	8.00
2	BLUE	-0381	J11-H	SOLDER	TB1-4	SOLDER	7.00
3	W/BLK	-0392	J11-F	SOLDER	TB2-4	SOLDER	16.00
4	W/RED	-0386	J11-E	SOLDER	TB1-5	SOLDER	7.50
5	GRAY	-0385	J11-A	SOLDER	TB2-6	SOLDER	15.00
6	GRAY	-0385	J11-B	SOLDER	TB2-7	SOLDER	14.50
7	W/BLUE	-0389	J11-C	SOLDER	TB1-B	SOLDER	9.00
8	W/BLUE	-0389	J11-D	SOLDER	TB1-7	SOLDER	8.50
9	BLACK	-0384	J11-J	SOLDER	GND	SOLDER	6.00
10	BROWN	-0383	TB1-1	SOLDER	R33-1	SOLDER	15.00
11	YELLOW	-0379	TB1-2	SOLDER	Q4-E	SOLDER	11.50
12	GREEN	-0380	A2-E3	SOLDER	Q3-B	SOLDER	14.50
13	BLUE	-0381	TB1-4	SOLDER	Q4-C	SOLDER	11.00
14	W/BRN	-0391	TB2-1	SOLDER	R33-3	SOLDER	4.00
15	VIOLET	-0382	TB2-2	SOLDER	R31-1	SOLDER	7.00
16	W/VIOL	-0390	TB2-3	SOLDER	R31-3	SOLDER	6.50
17	W/GRN	-0388	TB2-5	SOLDER	R32-3	SOLDER	4.50
18	BLUE	-0381	TB2-B	SOLDER	Q3-C	SOLDER	7.00
19	W/VIOL	-0390	R31-3	SOLDER	R32-1	SOLDER	7.00
20	GREEN	-0380	Q3-E	SOLDER	Q4-B	SOLDER	14.00
21	BROWN	-0383	R33-1	SOLDER	R33-2	SOLDER	3.50
22	W/VIOL	-0390	R32-1	SOLDER	R32-2	SOLDER	3.50
23	VIOLET	-0382	R31-1	SOLDER	R31-2	SOLDER	3.50

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

FIND NO	CODE IDENT	DWG SIZE	PART OR IDENTIFYING NO	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
6			Type F, Form UA Grade A, Cl I Category 1	9	Insulation, Electrical .027 ID X .012 Wall (#22 AWG) X .375 Lg., Color - Transparent	MIL-I-631	
5			SNGOWRAP-2	AR	Solder, LEAD-TIN ALLOY ROSIN CORE	QQ-S-571	NOTE 4
4			MS39020-1	1	Band, Marker		Al Aly
3			MS3367-4-9	27	Strap, TIEDOWN		Nylon
2			MS3102R18-1S	1	Connector, Receptacle		
1			Type-C-22	AR	Wire, Electrical	MIL-W-16878/2	

Figure 6-13. Voltage Regulator, Wiring Harness

a. Secure voltage regulator in position with four screw assemblies.

b. Reconnect connector P11 to voltage regulator.

c. Return cover to exciter-regulator A11 and secure in places with eight screw assemblies.

d. Mount exciter-regulator A11 in place and secure with four screws.

e. Reconnect connectors to side of exciter-regulator A11.

6-24. ADJUSTMENT. To adjust voltage regulator A11 proceed as follows:

a. Remove document storage box and adjustment access plate (48, figure 6-9) from top of exciter-regulator.

b. Start engine and allow for sufficient warm up time before proceeding to next step.

c. Set voltage range control resistor R33 to mid-range.

d. Adjust VOLTAGE ADJUST control resistor R2 (located on control cubicle) as follows: between 395 and 480 volts for the 240/416 volt connection and between 197 and 240 volts for the 120/208 volt connection for 60 Hertz; or between 380 and 426 volts for the 240/416 volt connection and between 190 and 213 volts for the 120/208 volt connection for 50 Hertz.

e. Set feedback resistor R32 and rate resistor R31 to mid-range. If voltage is stable adjust feedback resistor R32 counterclockwise until output voltage becomes unstable, then turn clockwise until voltage is stable. If voltage is still unstable turn feedback resistor R32 slowly counterclockwise until voltage is stable. If voltage stability is still not achieved, adjust rate resistor R31 slightly counterclockwise from mid-range and readjust feedback resistor R32.

Section IV. MAINTENANCE OF CIRCUIT BREAKER ASSEMBLY CB2

6-25. GENERAL. Main circuit breaker assembly CB2 connects and disconnects the generator output to and from the load circuits. The circuit breaker itself, although mechanical, operates electrically by means of a motor control which clamps over the front surface of the circuit breaker. The motor control, by means of a quick-release screw, may be lifted clear of the device, allowing for the manual operation of the circuit breaker. The circuit breaker will open its switch contacts automatically in the event of an abnormal and possibly damaging situation. Refer to the Operator and Organizational Maintenance Manual for circuit breaker theory of operation.

6-26. ON-EQUIPMENT TEST. To test main circuit breaker assembly CB2, refer to the Operator and Organizational Maintenace Manual.

6-27. REMOVAL. To remove main circuit breaker assembly CB2, refer to the Operator and Organizational Maintenance Manual.

6-28. TEST. To test main circuit breaker assembly CB2, proceed as follows:

a. Connect CB2 to test equipment shown in figure 6-14.

b. Set all test switches to open.

c. Perform tests specified in procedural analysis table 6-6.

d. Deenergize and disconnect test setup.

6-29. DISASSEMBLY. To disassemble main circuit breaker assembly CB2, refer to figure 6-15 and proceed as follows:

a. Remove screws (1), lockwashers (2), and washers (3); then separate bracket (4) from bracket (29).

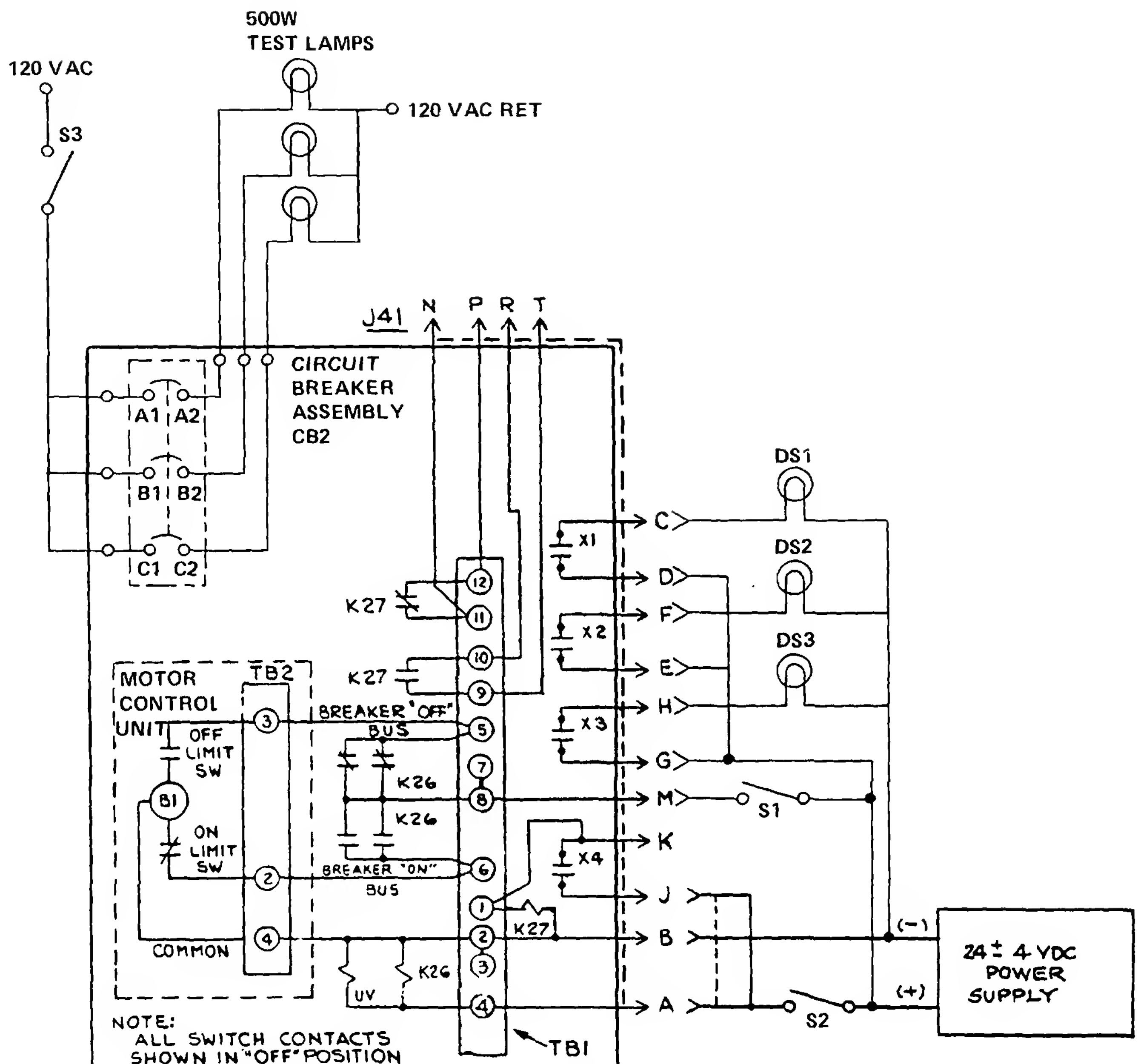


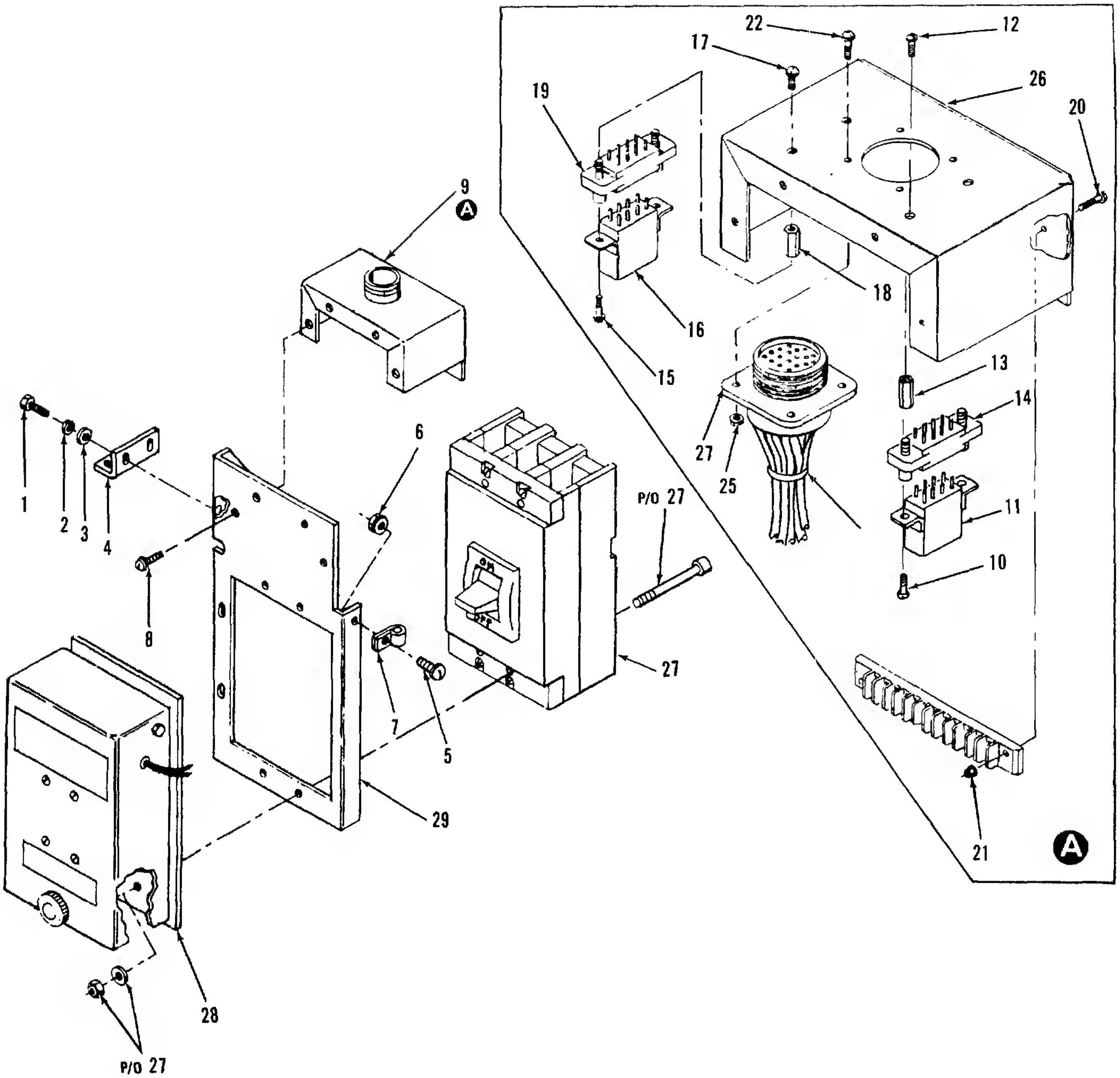
Figure 6-14. Circuit Breaker Assembly CB2, Test Setup

Table 6-6. Main Circuit Breaker Assembly CB2, Procedural Analysis

STEP	TEST CONDITION	REQUIRED RESULT	PROBABLE CAUSE FOR IMPROPER RESULT	CHECK OUT PROCEDURE
		NOTE Motor control unit is lifted clear of circuit breaker assembly during the following tests.		
1.	With all test switches open, and motor control indicator in the green "OFF" position, close switch S1 and S2.	Motor B1 should energize, and indicator should position to red "ON".	Defective relay K26.	Test and replace K26 as required (refer to figure 6-14 for K26 schematic diagram).
			Motor control unit defective.	Replace motor control unit.
2.	Open switch S1 and close switch S2.	Motor B1 should energize and indicator should position to green "OFF".	Defective relay K26.	Test and replace K26 as required (refer to figure 6-14 for K26 schematic diagram).

Table 6-6. Main Circuit Breaker Assembly CB2, Procedural Analysis (Continued)

STEP	TEST CONDITION	REQUIRED RESULT	PROBABLE CAUSE FOR IMPROPER RESULT	CHECK OUT PROCEDURE
3.	Close all test switches. Manually close circuit breaker.	Each 500 W test lamp should light and stay lit (lamps should not flicker).	If lamps do not stay lit, then UV relay is probably defective.	Test and replace main circuit breaker, as required.
			If lamps flicker, circuit breaker base is probably defective.	Test and replace main circuit breaker, as required.
		DS1, DS2, and DS3 should each light.	Defective auxiliary switch assembly.	Test and replace main circuit breaker, as *required*.
4.	Using ohmmeter, check for continuity between TB1-9 and TB1-10.	There should be continuity.	Relay K27 is probably defective.	Test and replace K27, as required, (refer to figure 6-14 for K27 schematic diagram).
5.	Open all test switches. Check for continuity between TB1-11 and TB1-12.	There should be continuity.	Relay K27 is probably defective.	Test and replace K27, as required, (refer to figure 6-14 for K27 schematic diagram).



1. SCREW
2. LOCKWASHER
3. WASHER
4. BRACKET
5. SCREW AND WASHER ASSY
6. NUT AND WASHER ASSY
7. CLAMP
8. SCREW AND WASHER ASSY
9. RELAY BOX
10. SCREW AND WASHER ASSY
11. RELAY
12. SCREW
13. STANDOFF
14. RELAY SOCKET
15. SCREW AND WASHER ASSY
16. RELAY
17. SCREW
18. STANDOFF
19. RELAY SOCKET
20. SCREW AND WASHER ASSY
21. NUT AND WASHER ASSY
22. SCREW AND WASHER ASSY
23. NUT AND WASHER ASSY
24. TIEWRAP
25. CONNECTOR
26. RELAY BOX COVER
27. MAIN CIRCUIT BREAKER CB2
28. MOTOR CONTROL
29. BRACKET

Figure 6-15. Circuit Breaker Assembly CB2, Exploded View

b. Remove clamp (7) by first removing nut and washer assembly (6) and screw (5).

c. Remove relay box assembly (9) by removing screws (8).

d. To remove relays (11 or 16), remove either screws (10) or screws (15) and unplug relay.

e. To remove relay sockets (14 or 19), unsolder, disconnect and tag wires leading to these sockets, unscrew screws (12 and 17) and remove sockets. Collect standoffs (13 and 18) and store.

f. To remove connector (25), unscrew four screws (22) and nuts (23).

g. To separate main circuit breaker CB2 from bracket (29) and motor control (28), remove four screws, lockwashers, and nuts (all three are considered part of main circuit breaker).

h. Remove main circuit breaker CB2 (27).

6-30. REPAIR OR OVERHAUL. Repair CB2 by replacing defective parts. To overhaul CB2, proceed as follows:

a. Repair cracked sheet metal parts by welding. Straighten distorted parts using suitable tools.

b. Chase damaged threads in mount.

c. Remove damaged paint. Blend in edge, prime, and paint damaged areas.

d. Repair or fabricate circuit breaker wiring in accordance with figures 6-16 and 6-17 and paragraph 6-66.

e. Replace damaged or defective components.

6-31. REASSEMBLY. To reassemble main circuit breaker assembly CB2, refer to figure 6-15 and proceed as follows:

a. Place bracket (29) over front of main circuit breaker. Run four screws (part of circuit breaker) through circuit breaker (27) and bracket (29).

b. Place motor control unit (28) over circuit breaker (27) with cover open and circuit breaker handle in the OFF position. Adjust sliding carriage of motor control unit (by turning slot at end of worm gear with screwdriver) until it engages the circuit breaker handle. Secure with washers and nuts (part of circuit breaker). Secure knurled locking knob on motor control.

c. Secure connector (25) to relay box cover (26) with screws (22) and nuts (23).

d. Thread standoffs (13 and 18) onto relay sockets (14 and 19) and secure to relay box cover (26) with screws (12 and 17).

e. Connect all tagged electrical leads to existing terminals.

f. Install relays (11 and 16) into relay sockets (14 and 19) and secure with screw and washer assemblies (10 and 15).

g. Place relay box (9) over bracket (29) and secure with screw and washer assemblies (8).

h. Secure clamp (7) to bracket (29) with nut and washer assembly (6) and screw and washer assembly (5).

i. Fasten bracket (4) to side of bracket (29) with washers (3), lockwashers (2), and screws (1).

6-32. INSTALLATION. To install CB2 refer to the Operator and Organizational Maintenance Manual.

SECTION IV A. ALTERNATIVE MAIN CIRCUIT BREAKER (LOAD CONTACTOR).

6-32A. GENERAL. Main Load Contactor assembly CB2 connects and disconnects the generator output to and from the load circuits. The Load Contactor itself, although mechanical, operates electrically and is a sealed, non-repairable, unit. The load contactor will open its switch contacts automatically in the event of an abnormal and possibly damaging situation. Refer to the Operator and Organizational Maintenance Manual for load contactor (Circuit breaker) theory of operation.

6-32B. ON-EQUIPMENT TEST. NOT APPLICABLE.

6-32C. REMOVAL. To remove main Load Contactor assembly CB2, refer to the Operator and Organizational Maintenance Manual.

6-32D. TEST. To test main Load Contactor assembly CB2, proceed as follows:

a. Connect CB2 to test equipment shown in figure 6-15A.

b. Set all test equipment shown in figure 6-14A.

c. Perform test specified in procedural analysis table 6-6A.

d. Deenergize and disconnect test set-up.

6-32E. DISASSEMBLY. To disassemble main Load Contactor assembly CB2, refer to figure 6-15B and proceed as follows:

a. Remove screws (21), lockwashers (23), and washers (22) then separate bracket (1) from bracket (20).

b. Remove wire leads from brackets (3 and 2) by removing screws (9 and 10), nuts (13), lockwasher (12) and flat washer (11). Bolt locking brackets (4) should be removed and stored.

c. Remove brackets (3 and 2) from bracket (1) by removing screws (14), flat washer (15) and self locking nuts (16).

d. remove other end of wire leads from load contactor by removing protective covers and nuts from load contactor.

e. Remove load contactor (6) from bracket (1) by removing screws (17), flat washers (18), and nuts (19).

6-32F. REPAIR or OVERHAUL. Repair CB2 by replacing defective parts. The load contactor (6) is a non-repairable item and should be replaced. To overhaul the remainder of CB2, proceed as follows:

a. Repair cracked sheet metal parts by welding, straighten distorted parts by using suitable tools.

b. Chase damaged threads in mount.

c. Remove damaged paint. Blend in edge, prime and paint damaged areas.

d. Repair wire leads by removing damaged lugs or wires. Cut new wire to length and crimp new lug.

6-32G. REASSEMBLY. To reassemble main load contactor assembly CB2, refer to figure 6-15B and proceed as follows:

a. Mount bracket (20) to bracket (1) using screws (21), flat washers (22), and lock washers (23).

b. Mount circuit breaker (6) to bracket (1) using screws (17) and flat washer (18).

c. Mount angles (2) and (3) using screws (14), flat washers (15), and self locking nuts (16).

d. Connect wire leads (5) to circuit breaker using existing hardware on circuit breaker.

e. Connect other end of wire leads to angles using screws (10), locking bracket (4), flat washers (11), lock washer (12), and nuts (13).

f. Mount cable protector (8) to top corner of bracket (1).

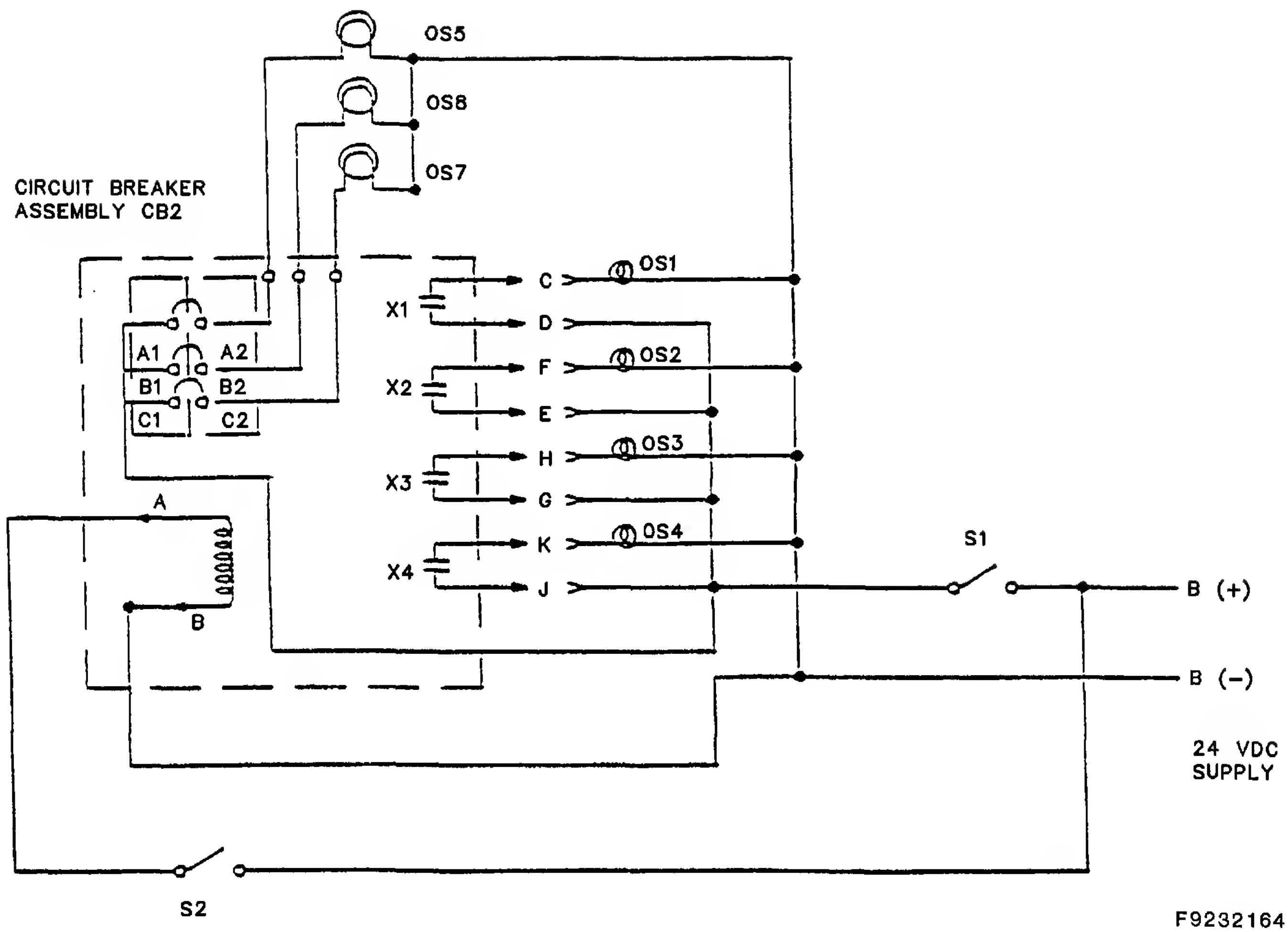
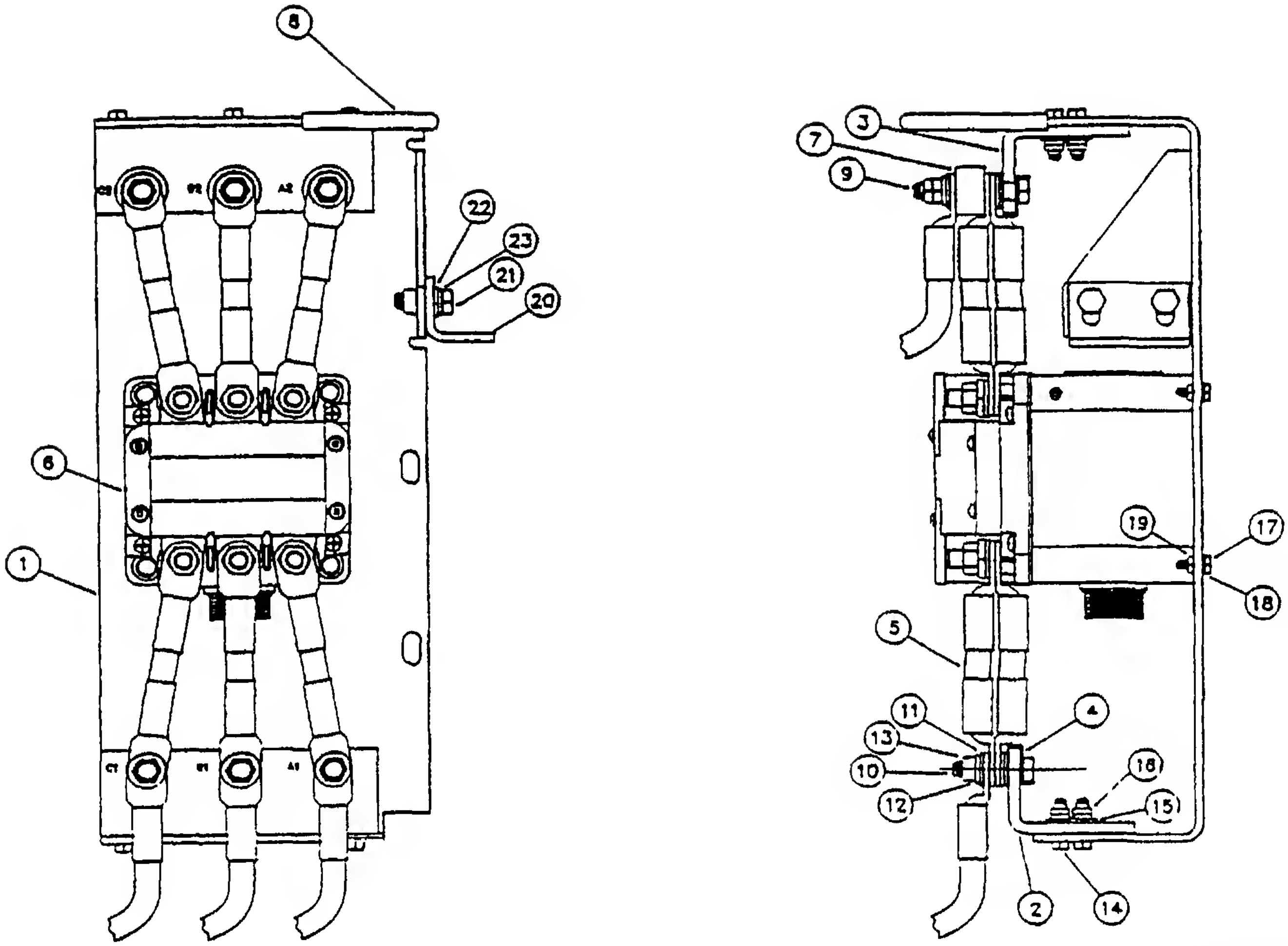


Figure 6-15A. Alternate circuit breaker, 90-4001 (load contactor) CB2 set-up

TABLE 6-6A ALTERNATE CIRCUIT BREAKER ASSEMBLY CB2, PROCEDURAL ANALYSIS

STEP	TEST CONDITION	REQUIRED RESULT	PROBABLE CAUSE FOR IMPROPER RESULT	CHECKOUT PROCEDURE
1	WITH SWITCH S1 CLOSED & SWITCH S2 OPEN	NO LIGHTS SHOULD COME ON	DEFECTIVE LOAD CONTACTOR	REPLACE COMPLETE LOAD CONTACTOR
1	WITH SWITCH S1 CLOSED AND SWITCH S2 CLOSED	ALL LIGHTS SHOULD COME ON	DEFECTIVE LOAD CONTACTOR	REPLACE COMPLETE LOAD CONTACTOR



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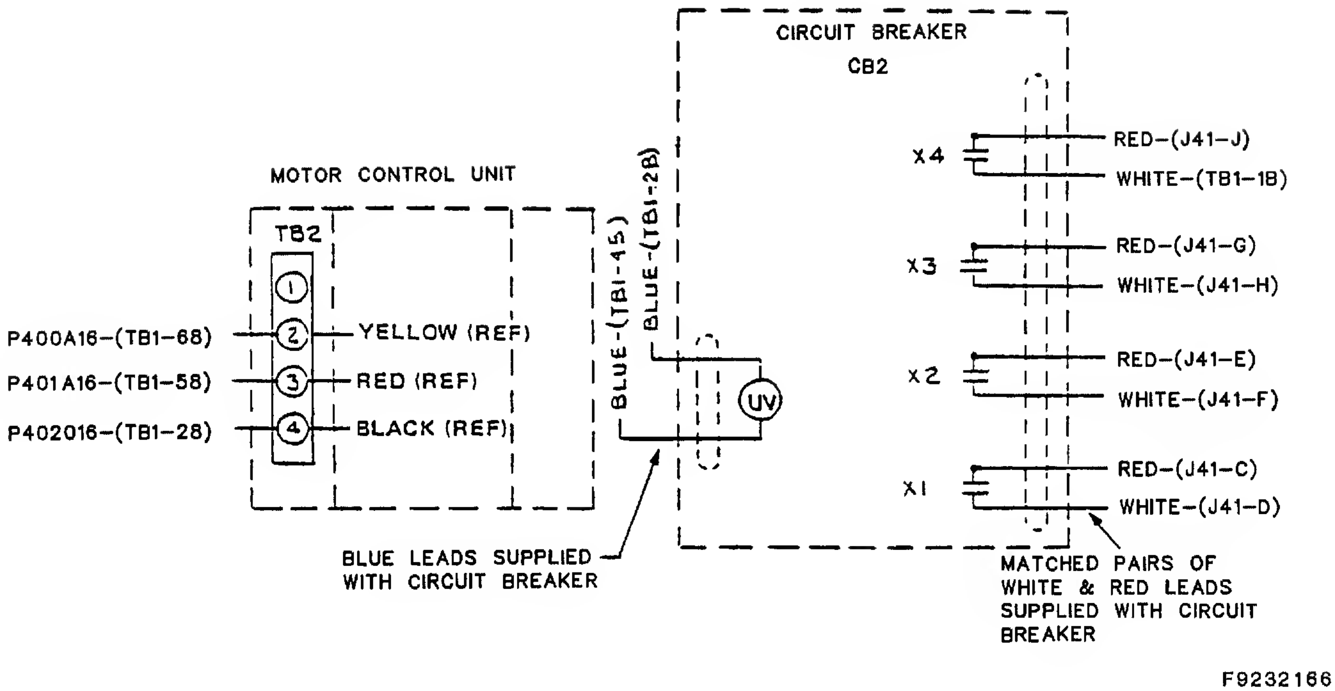
1. BRKT, LOAD CONTACTOR
2. ANGLE, GLASTIC
3. ANGLE, GLASTIC
4. BRKT, BOLT LOCKING
5. WIRE, LOAD CONTACTOR
6. LOAD CONTACTOR
7. SPACER LOAD CONTACTOR
8. ELE. CABLE PROTECTOR
9. SCREW, HEX HEAD
10. SCREW, HEX HEAD
11. FLAT WASHER
12. WASHER, SPLIT-LOCK
13. NUT, HEX-HEAD
14. SCREW, HEX HEAD
15. FLAT WASHER
16. NUT, SELF-LOCKING
17. SCREW, PAN HEAD
18. FLAT WASHER
19. NUT, KEP
20. BRACKET
21. SCREW, HEX HEAD
22. FLAT WASHER
23, WASHER, SPLIT-LOCK

Figure 6-15B. Alternate Circuit Breaker (Load Contactor Assembly) Detailed View

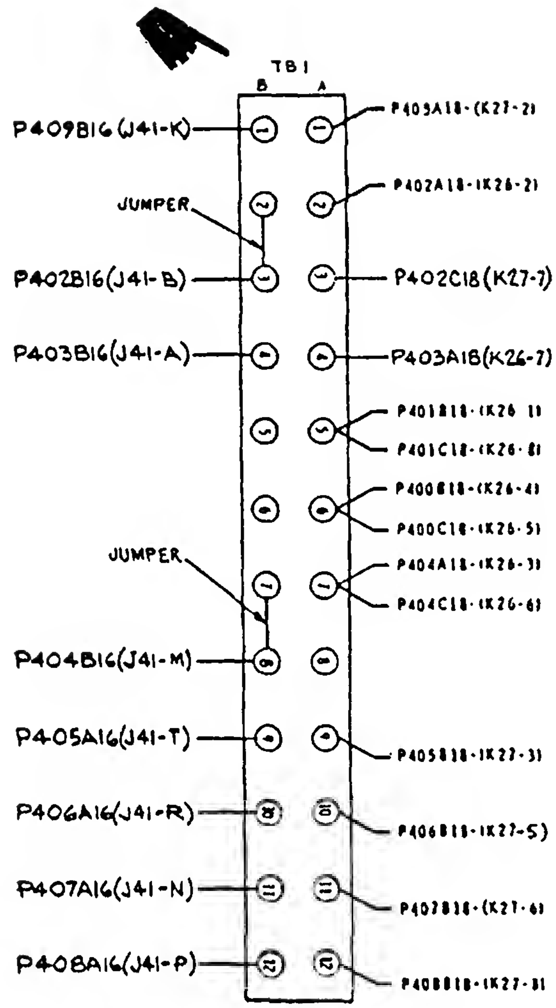


WIRE TABULATION						
IDENTIFICATION			TERM.		TERM.	LG
COLOR	NUMBER	FROM	NOTE	TO	NOTE	(IN.)
RED	PA02D16	TB1-28	2	TB2-4	2	25.00
BLK	PA01A16	TB1-3B	2	TB2-3	2	25.00
BLK	PA00A16	TB1-68	2	TB2-2	2	25.00
.						
RED	-	J41-C	1,4,5	CB2-X1	1,4,5,6	NOTES
WHITE	-	J41-0	↑	CB2-X1	↑	↑
RED	-	J41-E		C32-X2		
WHITE	-	J41-F		C32-X2		
RED	-	J41-G		C32-X3		
WHITE	-	J41-H		C32-X3	↓	
RED	-	J41-J	↓	C32-X4	1,4,5,6	
WHITE	-	J41-K	1,4,5	TB1-1B	2,6	
BLUE	-	C32-W	1,4,5	TB1-2B	2,6	↓
BLUE	-	C32-UV	1,4,5	TB1-4B	2,6	NOTES

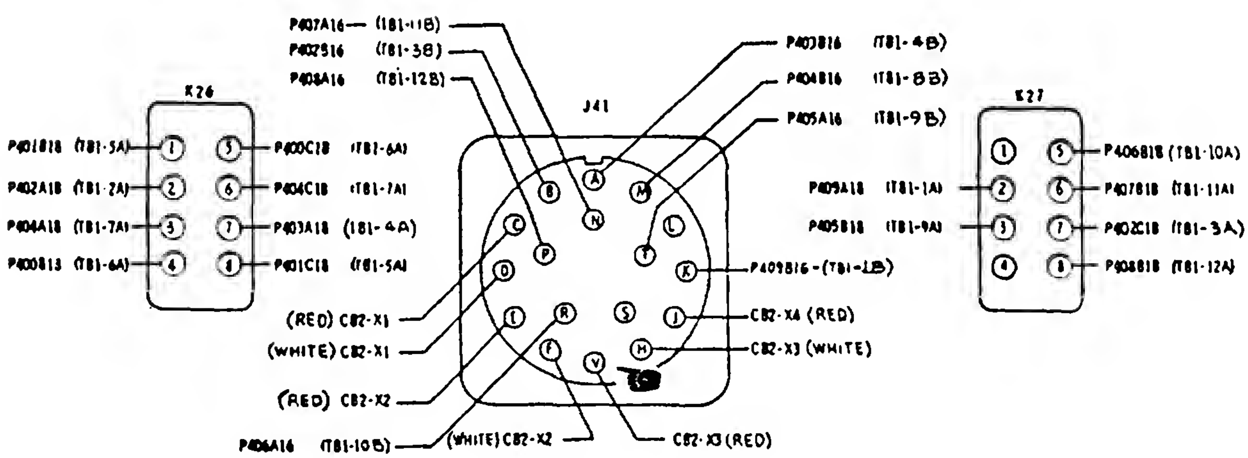
NOTES

1. Solder, use Federal Specification QQ-S-571. Sn 60.
2. Secure end with terminal lug, MS25036-106.
3. Wire is M5086/2-16-9 per MIL-W-5086/2.
4. Use a 5/8 inch long insulation tubing, TYPE F, FORM Ua, GRADE A, CLASS I, CATEGORY 1, over each contact after soldering.
5. Wire marking to be in accordance with MIL-W-5088, intervals shall not exceed 6.00 inches.
6. Wire lengths for wires supplied with circuit breaker to be determined at time of assembly.

Figure 6-16. Circuit Breaker Assembly CB2, Wiring Diagram



IDENTIFICATION COLOR	IDENTIFICATION NUMBER	FROM	TERMN NOTE	TO	TERMN NOTE	LG REF
RED	P403B16	J41-A	1,4,6,7	TB1-4B	2	8.00
RED	P402B16	J41-B		TB1-3B		7.00
BLK	P404B16	J41-M		TB1-8B		6.50
BLK	P407A16	J41-N		TB1-11B		8.00
BLK	P408A16	J41-P		TB1-12B		8.50
BLK	P406A16	J41-R		TB1 10E		7.50
BLK	P405A16	J41-T	1,4,6,7	TB1-9E	2	7.00
BLK	P401B18	K26-1	1,5,6,7	TB1-5A	3	7.00
RED	P402A18	K26-2		TB1-2A		5.00
BLK	P404A18	K26-3		TB1-7A		7.50
BLK	P400B18	K26-4		TB1-6A		7.50
BLK	P400C18	K26-5		TB1-6A		7.00
BLK	P404C18	K26-6		TB1-7A		8.00
RED	P403A18	K26-7		TB1-4A		5.50
BLK	P401C18	K26-8		TB1-5A		6.00
BLK	P406B18	K27-5		TB1 10A		6.00
BLK	P409A18	K27-2		TB1-1A		9.00
BLK	P405B18	K27-3		TB1-9A		7.00
BLK	P407B18	K27-6		TB1-11A		5.50
RED	P409C18	K27-7		TB1-3A		7.50
BLK	P408B13	K27-8	1,5,6,7	TB1-12A	3	5.00
BLK	P409B16	J41-K	1,4,6,7	TB1-15	2	8.00



NOTES

1. Solder, use Federal Specification QQ-S-571, Sn 60.
2. Secure end with terminal lug, MS25036-106.
3. Secure end with terminal lug, MS25036-102.
4. Wire is M5086/2-16-9 per MIL-W-5086.
5. Wire is M5086/2-18-9 per MIL-W-5086.
6. Use 5/8 inch long insulation tubing, TYPE F, FORM Ua, GRADE A, CLASS 1, CATEGORY 1, over each contact after soldering.
7. Wire marking to be in accordance with MIL-W-5088, intervals shall not exceed 6.00 inches.

Figure 6-17. Circuit Breaker Assembly CB2, Relay Box Wiring Diagram

Section V. MAINTENANCE OF PROTECTIVE RELAYS

6-33. GENERAL. The protective relays (overvoltage relay K2, reverse power relay K15, short circuit relay K13, and overload relay K14) are all mounted within tactical relay box A29.

a. Overvoltage Relay K2. Overvoltage relay K2 is a solid-state device which protects the load if generator voltage exceeds a preset limit. K2 actuates after a time delay from 180 to 800 milliseconds when generator voltage rises above 150 V ac. Upon actuation, one set of K2 contacts close to signal the fault indicator and another set opens to shut down the generator set.

b. Reverse Power Relay K15. Reverse power relay K15 is a solid-state device which protects the generator if a reverse power condition occurs during parallel operation. K15 operates with the load measurement unit which produces a dc output voltage whose polarity and magnitude is a function of the total load on the generator set, regardless of phase or power factor. When the reverse power flow into the generator exceeds 20 percent of rated load, the load measurement unit causes K15 to actuate. Upon actuation, K15 contacts close to signal the fault indicator and open to deenergize the main circuit breaker.

c. Short Circuit Relay K13. Short circuit relay K13 is a solid-state device which protects the load if generator ouput current in any phase exceeds 425 +/-25 percent of rated current. When the above fault occurs, K13 will actuate. Upon actuation, K13 contacts close to signal the fault indicator and open to deenergize the main circuit breaker.

d. Overload Relay K14. Overload relay K14 is a solid-state device whose function is to protect the load in the event of an overload; when generator output current in any phase exceeds 110 percent of rated value. K14 is a current sensing device that operates on an inverse time principle when the current in any phase exceeds the overload state. At the point just above 130 percent of rated current K15 will actuate within 8 +/-2 minutes. Upon actuation, K15 contacts close to signal the fault indicator and open to deenergize the main circuit breaker.

6-34. ON-EQUIPMENT TEST (OVERVOLTAGE RELAY K2). To test relay K2 proceed as follows:

NOTE

A malfunction of overvoltage relay K2 is usually indicated by failure of the generator fault monitoring system to detect and react to a voltage rise beyond preset limits.

a. Remove cover from tactical relay box A29 to gain access to test points (refer to figure 6-1).

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside tactical relay box with generator set operating.

b. Shut down engine. Disconnect and isolate wire connected to terminal 1 of relay K2. Connect the output of a variable 60 Hertz ac source (capable of producing an output of 160 V ac) across terminals 1 and 2 of relay K2.

c. Connect an ac voltmeter across terminals 1 and 2 of relay K2 (if variable ac source has a built-in meter, this step is not required).

d. Start engine and after generator set has stabilized, close main

circuit breaker to connect load.

e. Increase output of variable ac source until generator set shuts down. Voltage reading on ac voltmeter shoul be 153 +/-3 volts. If generator set fails to shut down or shuts down at a voltage other than 153 +/-3 volts, remove, check, and, if required, replace K2.

f. Shut down engine. Disconnect test equipment and reconnect wire to terminal 1 (disconnected as part of step b) of relay K2.

6-35. ON-EQUIPMENT TEST (REVERSE POWER RELAY K15). To test relay K15, proceed as follows:

NOTE

A malfunction of reverse power relay K15 is usually indicated by a failure of the generator set to detect and react to reverse power condition when operating in parallel.

a. Remove cover from tactical relay box A29 to gain access to test points (refer to figure 6-1).

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside tactical relay box with generator set operating.

b. Two generator sets shall be properly connected and setup to operate in parallel (refer to the Operator and Organizational Maintenance Manual).

c. Using a multimeter, measure the voltage across terminals 3 and 4 of relay K15; voltage reading should be 24 V dc.

d. Using a multimeter, measure the voltage across terminls 5 and 6 of relay K15; voltage reading should be 24 V dc.

e. Using a multimeter, measure the voltage across terminals 7 and 8 of relay K15; voltage reading should be zero.

f. Connect a dc voltmeter across terminals 1 and 2 of relay K15 (terminal 2 is positive); voltage reading should be 9.8 V dc (approximately) at 100 percent load.

g. Using engine manual speed control, slowly reduce speed of generator set under test while monitoring voltage across terminals 1 and 2 of relay K15; voltage reading should drop toward zero as engine speed is reduced. Eventually, as engine speed drops further, polarity of the voltage reading will reverse itself. At this point either exchange the leads of the multimeter or reset polarity switch on the multimeter.

h. As engine speed is further reduced, relay K15 should actuate (and the main circuit breaker open) when voltage on multimeter reads 2 +0.1 V dc (terminal 1 being positive). If main circuit breaker does not open and disconnect the load, remove, check, and replace relay K15 as required.

6-36. ON-EQUIPMENT TEST (SHORT CIRCUIT RELAY K13). To test relay K13, proceed as follows:

NOTE

A malfunction of the short circuit relay K13 is usually indicated by failure of the generator fault monitoring system to detect and react to a rise in generator current output (in any phase) beyond preset limits.

a. Remove cover from tactical relay box A29 to gain access to test points (refer to figure 6-1).

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside tactical relay box with generator set operating.

b. Shut down engine. Disconnect, tag, and isolate wire from terminal 1 of relay K13.

c. Connect the output, a variable 60 Hertz ac source (capable of producing an output between 0 and 50 V ac) across terminals 1 and 4 of relay K13. Set output of this source to minimum.

d. Connect an ac voltmeter across terminals 1 and 4 of relay K13 (if variable ac source has a built-in meter, this step is not required).

e. Start engine, and after generator set has stabilized, close main circuit breaker to connect load.

f. Increase output of variable ac source until main circuit breaker opens. Voltage reading on ac voltmeter should be 24 +/-0.3 V ac. If main circuit breaker fails to open or opens at a voltage outside above tolerance, check and replace K13.

g. Repeat steps b through f except in steps c and d connect equipment to terminals 2 and 4.

h. Repeat steps b through f except in steps c and d connect equipment to terminals 3 and 4.

i. Shut down engine, disconnect test equipment, and reconnect wires disconnected during test.

6-37. ON-EQUIPMENT TEST (OVERLOAD RELAY K14). To test overload relay K14, proceed as follows:

NOTE

A malfunction of overload relay K14 is usually indicated by failure of the generator set to detect and react to a current rise in any phase, beyond preset limits.

a. Remove cover from tactical relay box A29 to gain access to test points (refer to figure 6-1).

WARNING

Exercise extreme care not to touch exposed electrical connections when working inside tactical relay box with generator set operating.

b. Start engine. After engine has stabilized, close main circuit breaker.

c. Using a multimeter, measure the voltage across the terminals of K14 marked (+) and (-): the reading should be 24 V dc.

d. Using a multimeter, measure the voltage across the NO terminals of K14; the reading should be 24 V dc.

e. Connect the leads of the multimeter across the NC terminals of K14 and observe voltage reading; voltage reading should be zero.

f. Increase the load connected to phase A of the generator set to 130 percent of its rated value. The main circuit breaker should open (CKT BRK indicator light should go out) within 6 to 10 minutes and voltage reading across the NC terminals of K14 should rise to 24 V dc. If K14 fails to actuate, it

should be removed, tested, and, if required, replaced. If K14 actuates, proceed to next step.

g. Reduce load to rated value. Reset FAULT INDICATOR panel to off and main circuit breaker to closed position.

h. Repeat steps f and g except increase load to phase B.

i. Repeat steps f and g except increase load to phase C.

j. Shut down generator set, disconnect test equipment and close tactical relay box A29.

6-38. REMOVAL. To remove either relay K2, K15, K13 or K14, proceed as follows:

a. Shut down generator set.

b. Remove cover from tactical relay box A29 to gain access to relay being removed (refer to figure 6-1).

c. Disconnect connectors J51 and J4 from tactical relay box A29.

d. Remove two screws and washers (at base of A29) which secure A29 to mounting bracket and remove A29.

e. Tag and disconnect wires leading from relay being removed (11, 13, 15, or 17, figure 6-18).

f. Remove four sets of screws (10, 12, 14, or 16) that secure relay to bottom of chassis assembly (31) and remove relay being tested and/or replaced.

WARNING

Exercise care when making following test: the presence of high voltage may cause serious injury or death.

6-39. TEST (OVERVOLTAGE RELAY K2). To test relay K2, proceed as follows:

a. Connect overvoltage relay K2 to the test equipment shown in figure 6-19.

b. With all switches open, energize the 60 Hertz variable voltage supply and adjust voltage to 120 V ac. Close switch S2 then S3. Indicator DS1 should be lit and DS2 should be out.

c. Adjust 60 Hertz variable voltage supply to 157 V ac. Indicator DS1 should go out and DS2 should light.

d. If overvoltage relay K2 does not meet the requirements of the above tests, replace the relay.

e. Remove overvoltage relay K2 from the test equipment.

6-40. TEST (REVERSE POWER RELAY K15). To test relay K15, proceed as follows:

a. Connect reverse power relay K15 to the test equipment shown in figure 6-20.

b. Energize 24 V dc power supply and close switches S4 and S5. Indicator DS2 should be lit and DS1 should be out.

c. Set oscillator to 60 Hertz, 10 V peak-to-peak. Close switch S1 and set S2 to position "A". Increase variable voltage DC power supply to 10 V dc, then return to 0 V dc. Indicator DS2 should remain lit and DS1 should remain out.

d. Set switch S2 to position "B". Increase variable DC voltage slowly. Indicator DS2 should go out and DS1 energize at 2 V dc.

e. If reverse power relay does not meet the requirement of the above tests, replace the relay.

f. Remove reverse power relay K15 from the test setup.

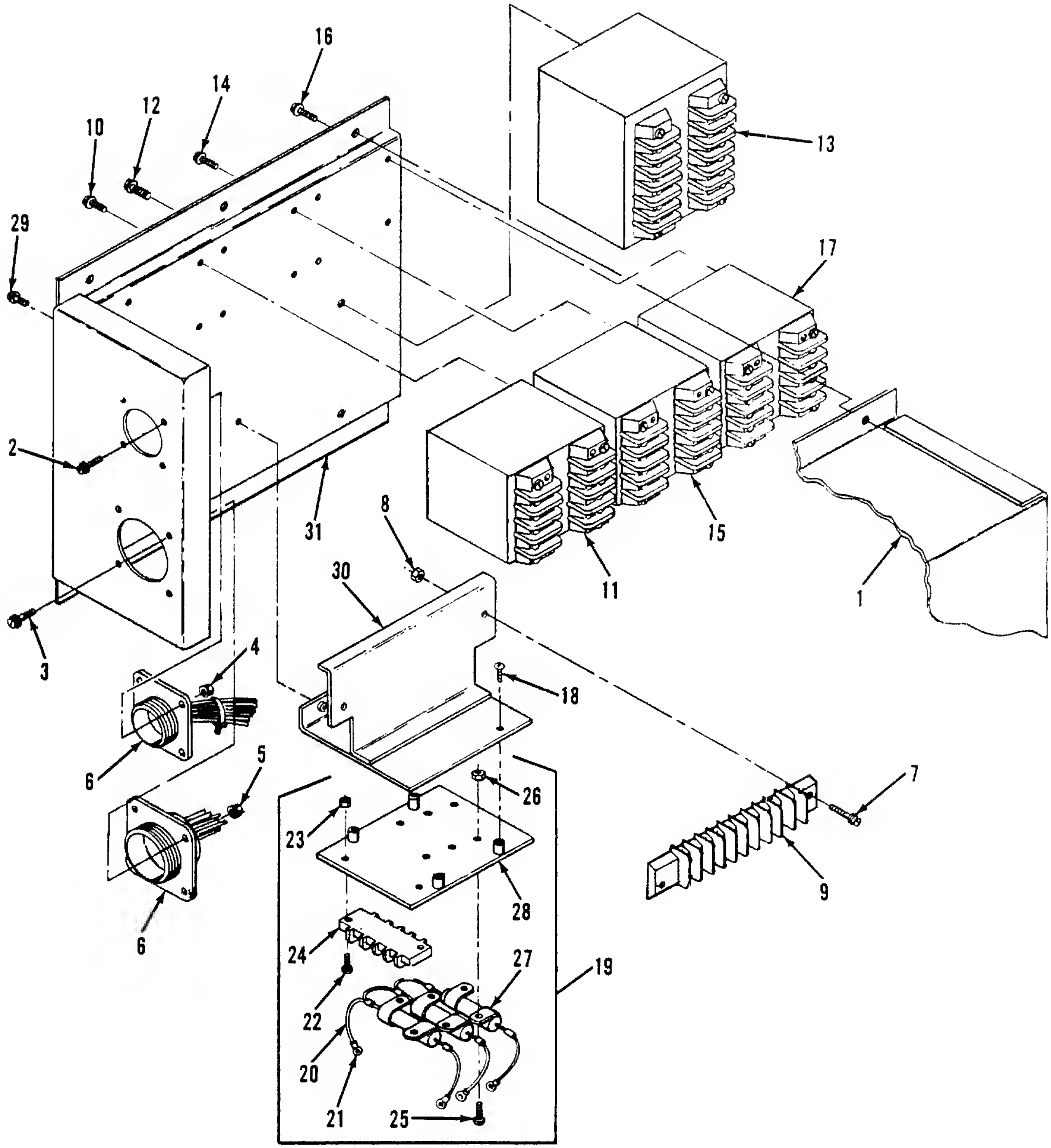


Figure 6-18. Tactical Relay Box A29, Exploded View (Sheet 1 of 2)

1. COVER
2. SCREW ASSY
3. SCREW ASSY
4. NUT
5. NUT
6. HARNESS ASSY
7. SCREW ASSY
8. NUT ASSY
9. TERMINAL BOARD (TB2)
10. SCREW ASSY
11. OVERVOLTAGE RELAY (K2)
12. SCREW ASSY
13. OVERLOAD RELAY (K14)
14. SCREW ASSY
15. SHORT CIRCUIT RELAY (K13)
16. SCREW ASSY
17. REVERSE POWER RELAY (K15)
18. SCREW ASSY
19. GOVERNOR RESISTOR ASSY
20. WIRE
21. TERMINAL LUG
22. SCREW
23. NUT ASSY
24. TERMINAL BOARD (TB4)
25. SCREW
26. NUT
27. RESISTOR (R1, R2, R3)
28. MOUNT
29. SCREW ASSY
30. BRACKET
31. CHASSIS ASSY

Figure 6-18. Tactical Relay Box A29, Exploded View (Sheet 2 of 2)

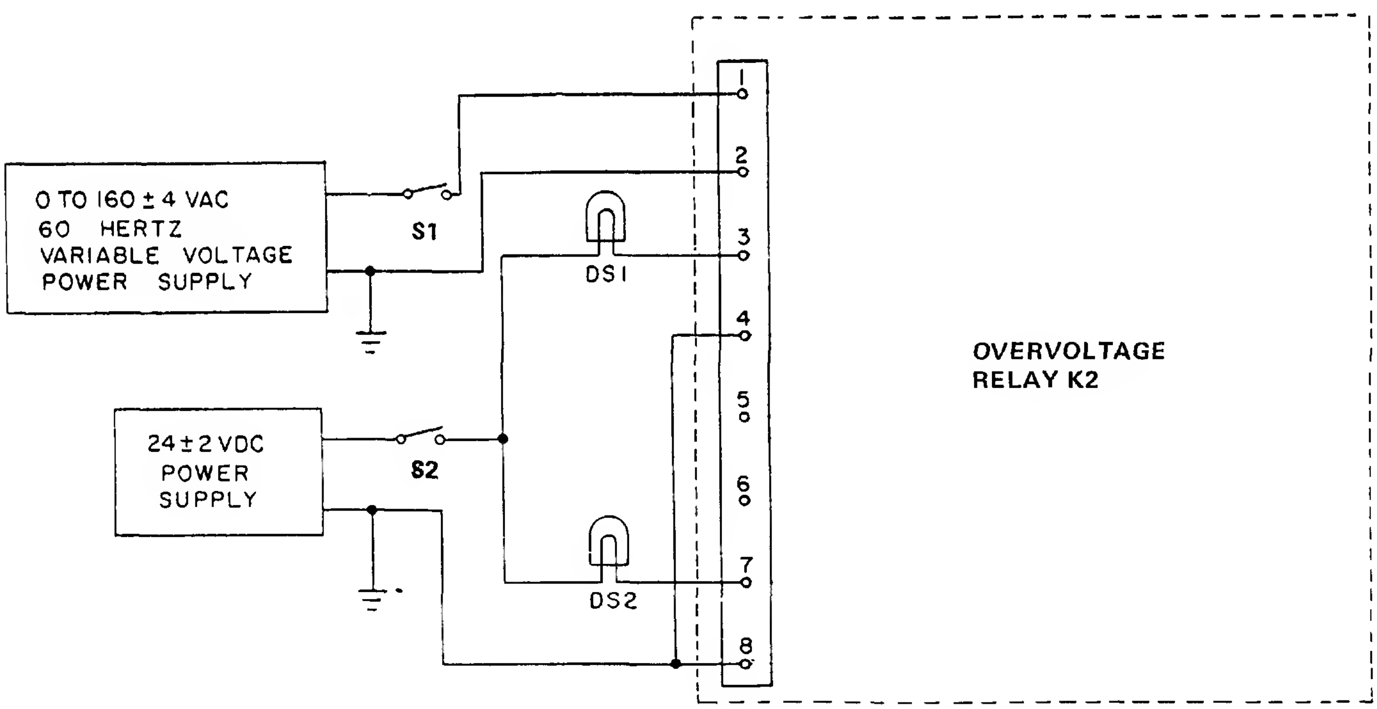


Figure 6-19. Over Voltage Relay K2, Test Setup

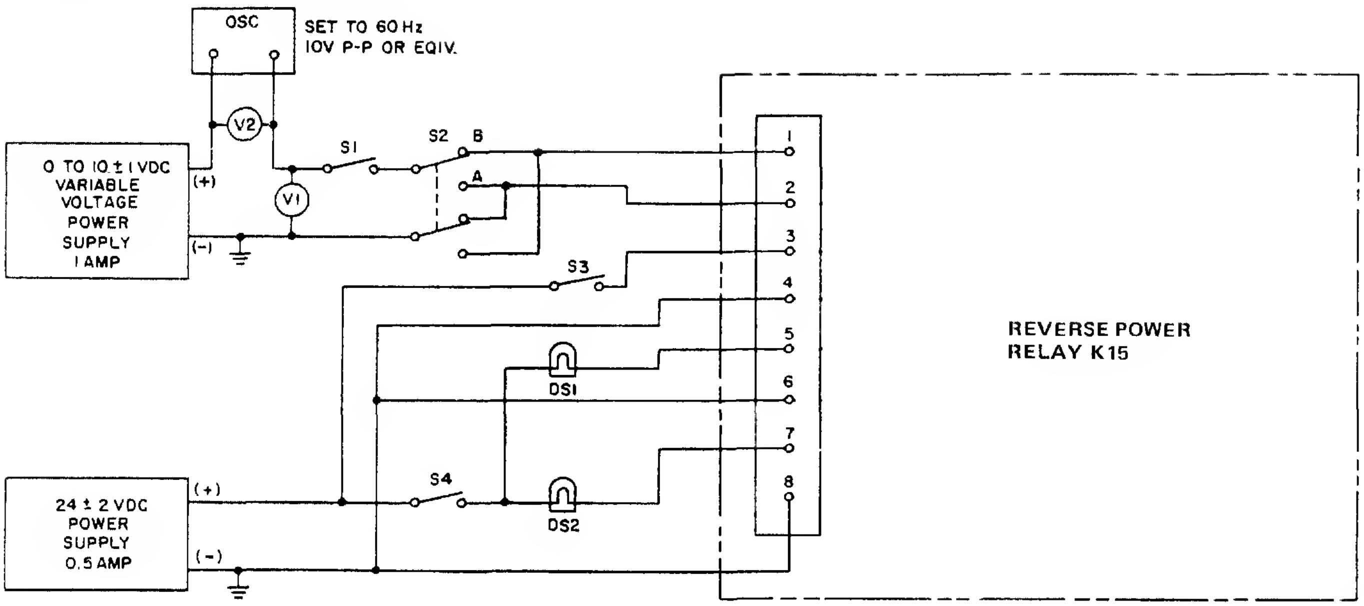


Figure 6-20. Reverse Power Relay K15, Test Setup

6-41. TEST (SHORT CIRCUIT RELAY K13). To test relay K13, proceed as follows·

a. Connect short circuit relay K13 to the test equipment shown in figure 6-21.

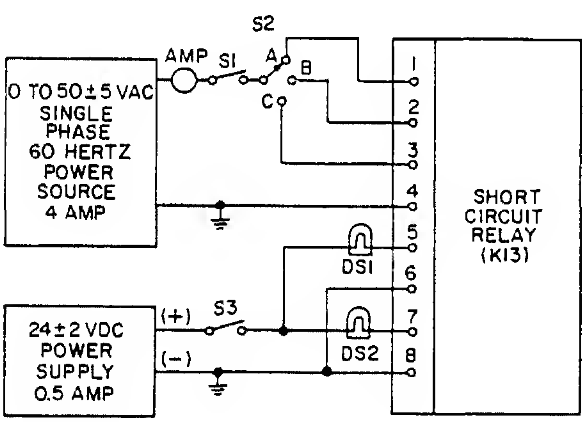


Figure 6-21. Short Circuit Relay K13, Test Setup

b. Energize 24 V dc power supply and close switch S3. Indicator DS1 should be lit and DS2 should be out.

c. Energize 0 to 50 variable power supply, set switch S2 to position "A" then close switch S1 and adjust power supply to obtain 3.375 amperes. Indicator DS2 should light and DS2 should go out. Open switch S1.

d. Repeat step c for switch S2 positions "B" and "C".

e. If short circuit relay K13 does not meet the requirements of the above tests, replace the relay.

f. Remove short circuit relay K13 from the test setup.

6-42. TEST (OVERLOAD RELAY K14). To test relay K14, proceed as follows:

a. Connect overload relay K14 to the test equipment shown in figure 6-22.

WARNING

Exercise care when making following test: the presence of high voltage may cause serious injury or death.

b. With the 120/208 V ac power source off, turn on the 24 V dc power supply and close switch S1. Indicator DS1 should light and indicator DS2 should be out.

c. Energize the 120/208 V ac power source and adjust autotransformers until ammeters A1, A2, and A3 each indicate 0.75 amperes. Indicators DS1 and DS2 should stay the same.

d. Adjust autotransformer T1 until ammeter A1 indicates 0.975 amperes. Within 6 to 10 minutes indicator DS1 should go out and indicator DS2 should light.

e. Readjust T1 for a reading of 0.75 amperes. Indicators DS1 and DS2 should return to states of step b; lit and not lit, respectively.

f. Repeat step d and e for autotransformer T2 and T3. The test results should be the same as the results for adjustment of autotransformer T1.

g. If overload relay K14 does not meet the requirements of the above test, it shall be replaced.

6-43. INSTALLATION. To install either relay K2, K15, K13, or K14, proceed as follows

a. Secure relay being installed to bottom of tactical relay box chassis assembly (31, figure 6-18) using four sets of screws (10 12, 14, or 16).

b. Connect wires to relay being installed as indicated by tags attached during removal procedures.

c. Secure base of tactical relay box to mounting bracket using two screws and washers

d. Reconnect connectors J51 and J4 to side of tactical relay box.

e. Replace and secure tactical relay box cover

f. Perform on-equipment test of installed relay (refer to either paragraph 6-34, 6-35, 6-36, or 6-37 as required)

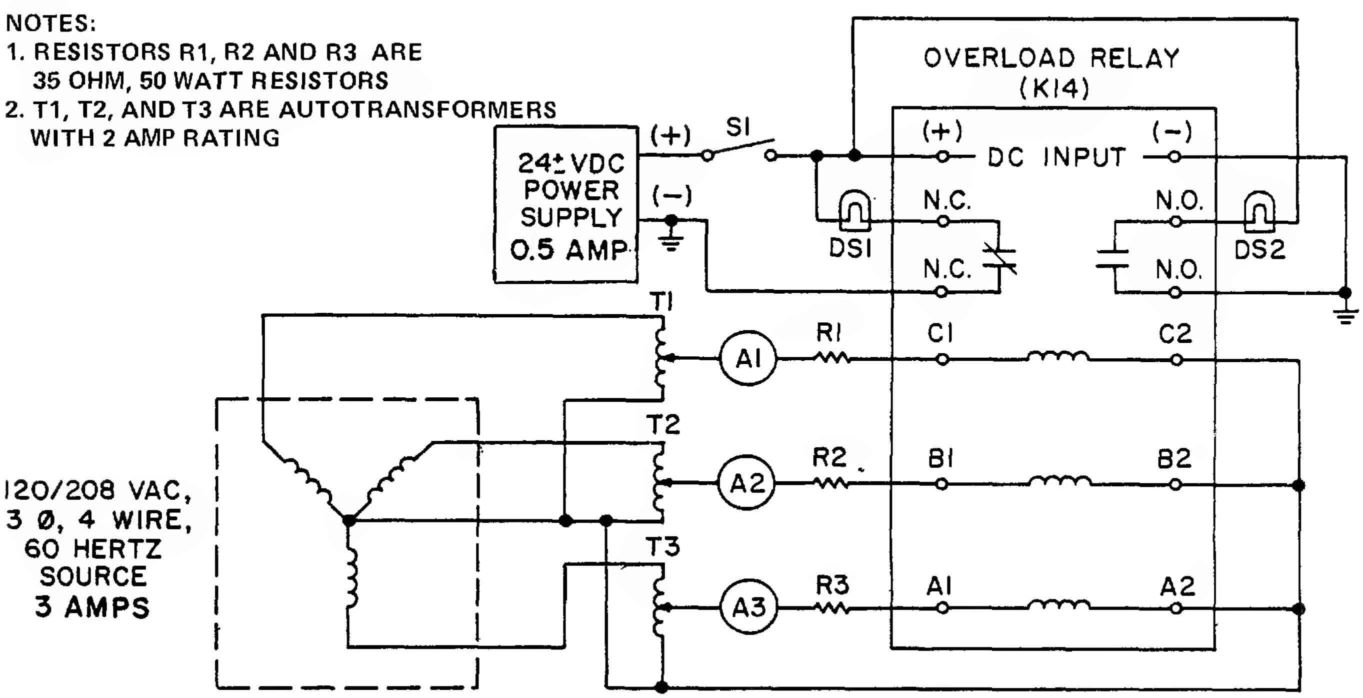


Figure 6-22. Overload Relay K14, Test Setup

Section VI. MAINTENANCE OF CONTROL RELAYS K1 AND K6

6-44. GENERAL. Control relay K1 (stop-run) latches the protective interlock circuit (overvoltage relay K2, oil pressure switch OP, water temperature switch WT, fuel level relay K8, and speed switch S9). Relay K6 (remote voltage sensing) switches output voltage sensing between remote and local positions. Relays K1 and K6 are identical.

6-45. REMOVAL. To remove either relay K1 or K6, proceed as follows:

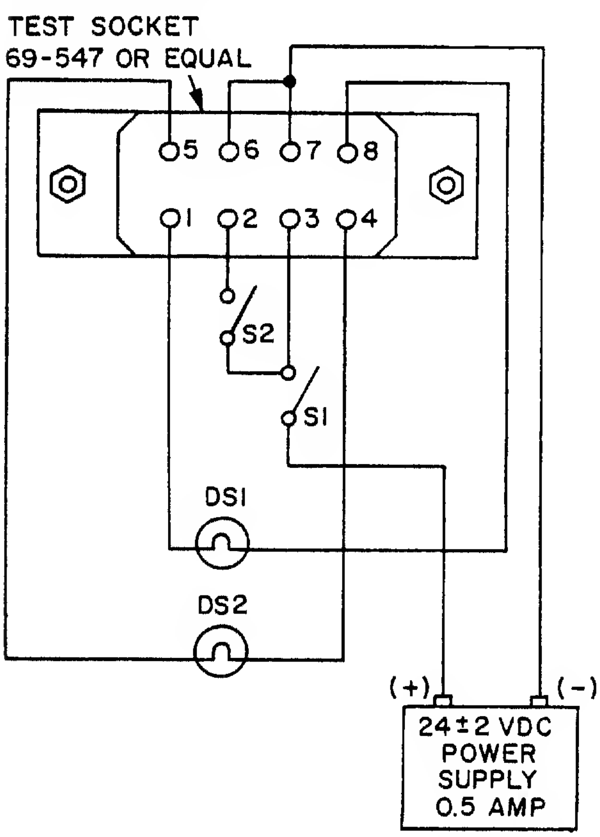
a. Shut down engine.
b. Turn three quick-release locking devices located at the top of control cubicle to release position.
c. Allow control cubicle panel to drop to open position.
d. Remove two screws and lockwashers that secure relays K1 and K6 to relay assembly A4 (mounted on rear of control cubicle).
e. Gently rock relay free of socket and remove.

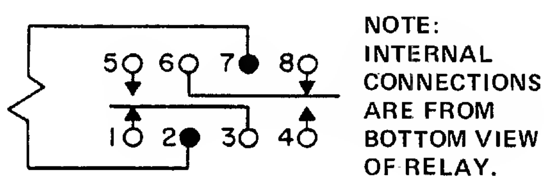
6-46. TEST. To test either relay K1 or K6 refer to figure 6-23 for test setup and procedure.

6-47. ADJUST. There are no adjustment procedures for either relay K1 or K6.

6-48. REPLACEMENT. To replace either relay K1 or K6, proceed as follows:

a. Observing pin orientation, insert relay into relay socket; ensure that relay is properly seated.
b. Using two screws and two lockwashers, secure relay to relay socket
c. Return control cubicle to its original position and secure it in place with three quick-release locking devices.





PROCEDURE:

STEP 1. PLUG RELAY INTO TEST SOCKET. TURN ON POWER SUPPLY.

STEP 2. CLOSE SWITCH S1; INDICATOR DS1 SHOULD LIGHT.

STEP 3. CLOSE SWITCH S2; INDICATOR DS2 SHOULD LIGHT AND INDICATOR DS1 SHOULD GO OUT.

STEP 4. TURN OFF POWER SUPPLY AND REMOVE RELAY FROM TEST EQUIPMENT. REPLACE DEFECTIVE RELAY.

Figure 6-23. Control Relay K1 and K6, Test Setup and Procedure

Section VII. MAINTENANCE OF CURRENT TRANSFORMER ASSEMBLY

6-49. GENERAL. The current transformer assembly is mounted to the right side of the generator and provides a mounting surface for the various current transformers of the generator set. The current transformers which comprise this assembly provide a means of monitoring generator output current flow by encircling the generator output cabling.

6-50. REMOVAL. To remove the current transformer assembly from the side of main generator G1, refer to figure 6-24 and proceed as follows:

a. Shut down engine

b. Lift off shield cover (4) after removing screws (1), lockwashers (2), and washers (3).

c. Tag and disconnect electrical connections from transformers and terminal board.

d. Cut tiedown straps connecting generator leads together. Tag and disconnect six generator leads that pass through transformers from reconnection board studs. Remove leads from transformer.

e. Lift current transformer assembly (9) clear of generator after removing spacers (5), screws (7), and lockwashers (6 and 8).

6-51. DISASSEMBLY. To disassemble current transformer assembly, refer to figure 6-25 and proceed as follows;

a. Remove two screws (2) to remove terminal board TB2.

b. To remove current transformer CT4, CT5, or CT6, remove four screw assemblies (4) and four washers (5)

c. To remove current transformer CT7 (9), remove four screws (7) and four washers (8).

NOTE

If it is necessary to separate current transformer CT7 from mounting brackets (13), remove two nuts (10) and two bolts (11).

d. To remove current transformers CT1, CT2, or CT3, remove four screws (17) and four washers (18).

6-52. TEST. To test any of current transformers CT1 through CT6 refer to figure 6-26.

NOTE

Allow at least 5 minutes for each test: overheating due to any shorted or partially shorted turns will be given sufficient time to appear.

6-53. REPLACEMENT. Current transformers are nonrepairable and must be replaced if defective. To replace a defective current transformer proceed as follows:

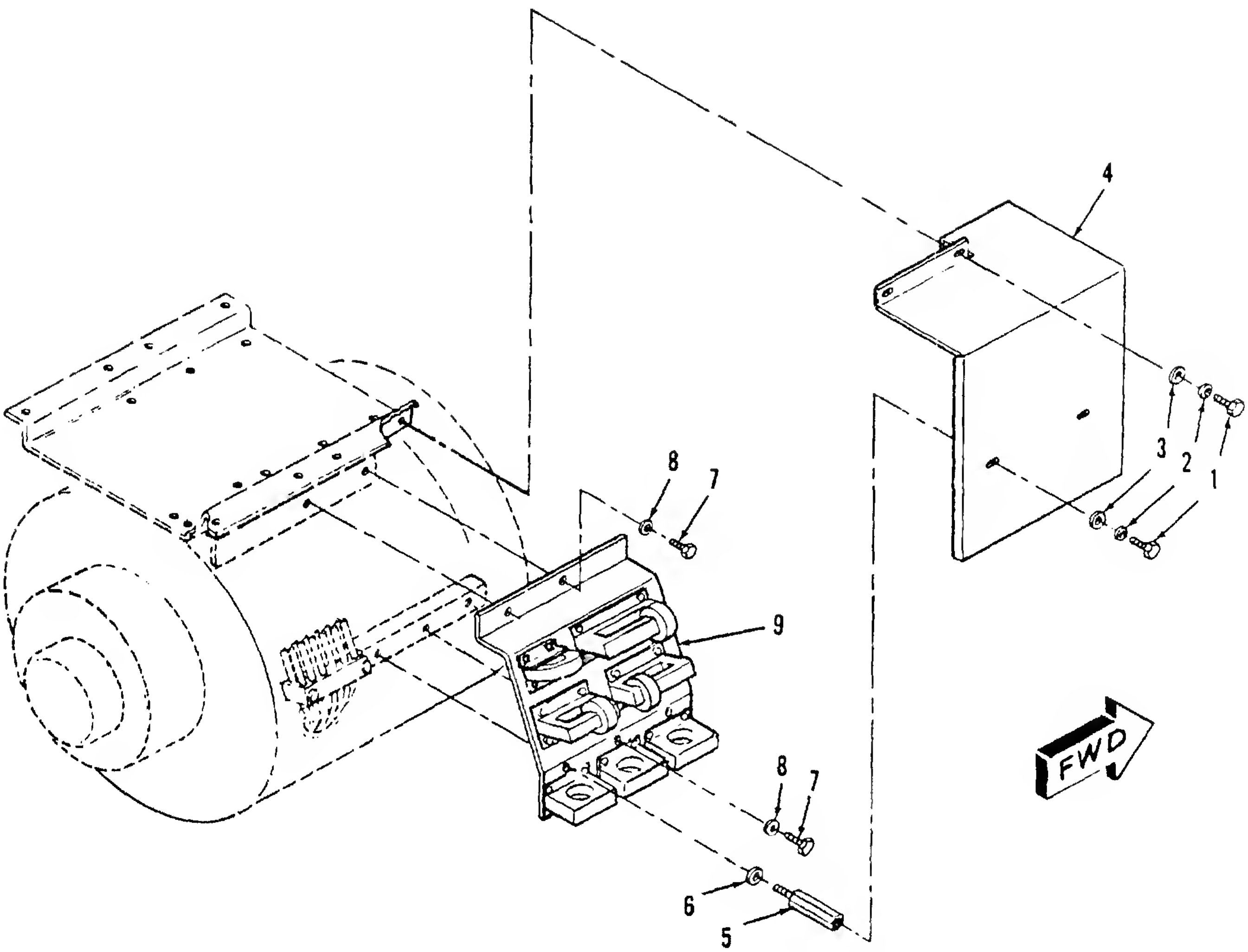
a. Remove defective transformer (refer to removal and disassembly procedures of paragraphs 6-50 and 6-51).

b. Mount current transformer in position and secure in place with original screws

NOTE

Make certain current transformer is secure; these devices have a tendency to vibrate if loose.

c. To complete replacement procedures, refer to next paragraph.



1. SCREW
2. LOCKWASHER
3. WASHER
4. SHIELD
5. SPACER
6. LOCKWASHER
7. SCREW
8. LOCKWASHER
9. TRANSFORMER ASSY

Figure 6-24. Current Transformer Assembly, Removal and Installation

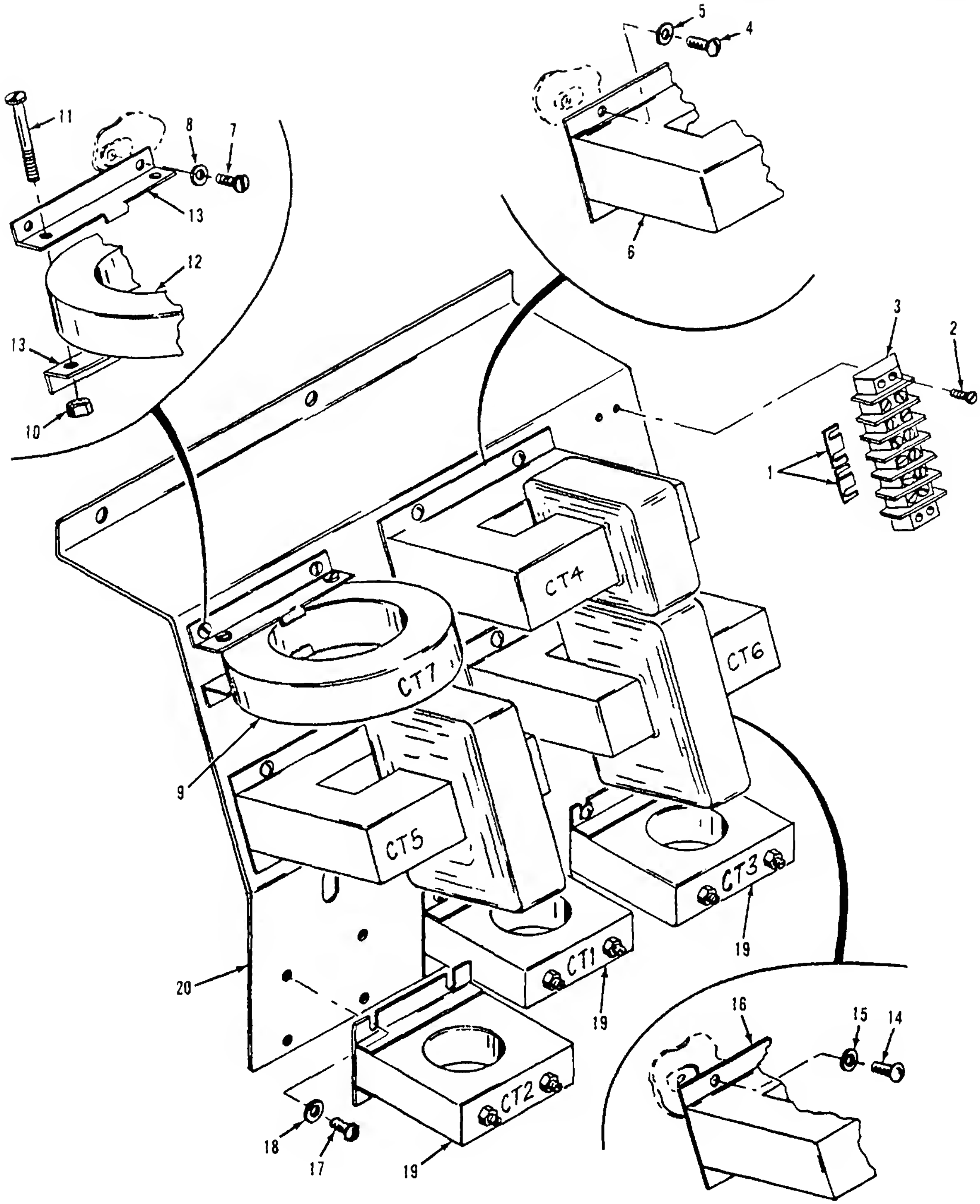
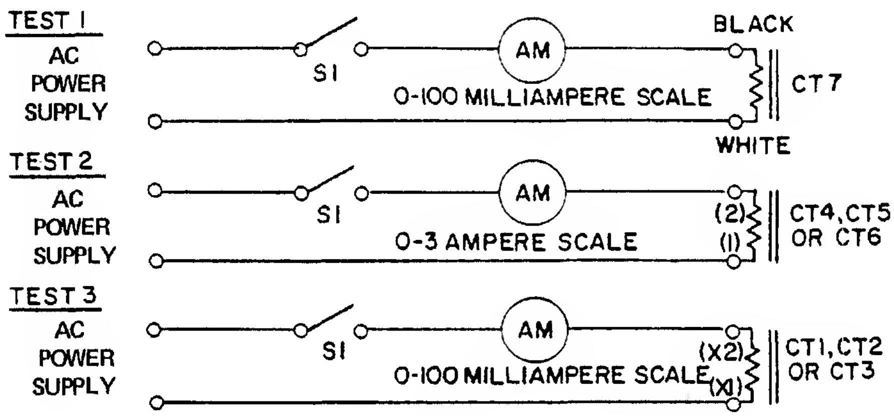


Figure 6-25. Current Transformer Assembly, Exploded View (Sheet 1 of 2)

1. JUMPER
2. SCREW
3. TERMINAL BLOCK
4. SCREW ASSY
5. WASHER
6. EXCITER TRANSFORMER (CT4)
7. SCREW
8. WASHER
9. CROSS CURRENT TRANSFORMER ASSY
10. NUT
11. BOLT
12. CURRENT TRANSFORMER (CT7)
13. BRACKET
14. SCREW
15. WASHER
16. EXCITER TRANSFORMER (CT5, CT6)
17. SCREW
18. WASHER
19. INSTRUMENT TRANSFORMER (CT1, CT2, CT3)
20. BRACKET

Figure 6-25. Current Transformer Assembly, Exploded View (Sheet 2 of 2)



TRANSFORMER	INPUT	MAXIMUM EXCITATION CURRENT	RESISTANCE VALUE ± 20 PERCENT	TEST SETUP
CROSSCURRENT TRANSFORMER CT7	10 VAC @ 60 HZ	0.05 AMPERES	2.5 OHMS	1
EXCITER CURRENT TRANSFORMER CT5 AND CT6	60 VAC @ 60 HZ 35 VAC @ 400 HZ	0.90 AMPERES 1.0 AMPERES	0.22 OHMS 0.05 OHMS	2 2
EXCITER CURRENT TRANSFORMER CT4	60 VAC @ 60 HZ 40 VAC @ 400 HZ	0.30 AMPERES 0.50 AMPERES	0.83 OHMS 0.15 OHMS	2 2
INSTRUMENT CURRENT TRANSFORMERS CT1, CT2, AND CT3	12.5 VAC @ 60 HZ	0.05 AMPERES	1.35 OHMS	3

Figure 6-26. Current Transformer, Test Setup

6-54. INSTALLATION. To install current transformer assembly, refer to figure 6-24 and proceed as follows:

a. Place current transformer assembly (9) on side of generator and secure in place with spacers (5), screws (7), and lockwashers (6 and 8)

b. Refer to the Operator and Organizational Maintenance Manual for current transformer assembly wiring arrangement and, observing tagging, route cabling through current transformers.

c. Connect wiring as indicated by tagging.

d. Secure wiring and cabling with ties as noted during removal procedures.

e. Secure terminal board in place with two screws.

f. Place shield over assembly and secure in place with four screws (1), lockwasher (2), and washer (3).

Section VIII. MAINTENANCE OF LOAD MEASUREMENT UNIT A8

6-55. GENERAL. Load measurement unit A8 (LMU) consists of a three-phase transformer rectifier and a variable load resistor. The LMU measures the total load on the generator set regardless of power factor or phase and provides a dc voltage proportional to this load.

6-56. ON-EQUIPMENT TEST. To test the LMU, proceed as follows:

a. With generator set operating at rated speed and voltage, measure at points V1, V2, and V3 (to neutral) at watt converter: voltage should be 120 V ac nominal. Also measure voltage across points L1, L2, and L3 of watt converter: voltage should be 5.6 V ac at rated load.

b. If above voltages are met, connect connector P16 to LMU. Operate generator set, controlling speed with the manual speed control and check load measurement unit output (J16 - S and N) at TB2 - 6 and TB2 - 7 of tactical relay box A29 (refer to Section I of this Chapter). Voltage should be 9.8 V dc with generator set operating at rated load.

c. If input voltages are correct and the output does not vary between 0 and 9.8 V dc proportional to load, the LMU should be replaced.

6-57. REMOVAL. To remove the LMU refer to figure 6-27, and proceed as follows:

a. Shut down generator set.

b. Unplug P16 from top of LMU.

c. Remove four screw and washer assemblies; make certain to catch four nut and washer assemblies at rear of LMU mounting bracket.

d. Remove LMU.

6-58. TEST. To test the LMU, connect LMU to test equipment indicated in figure 6-28 and follow the step-by-step procedures in table 6-7

6-59. DISASSEMBLY. To disassemble the LMU, refer to figure 6-29 and proceed as follows:

a. Loosen and remove four nuts (2), four lockwashers (3), and four flat washers (4) to remove cover (5).

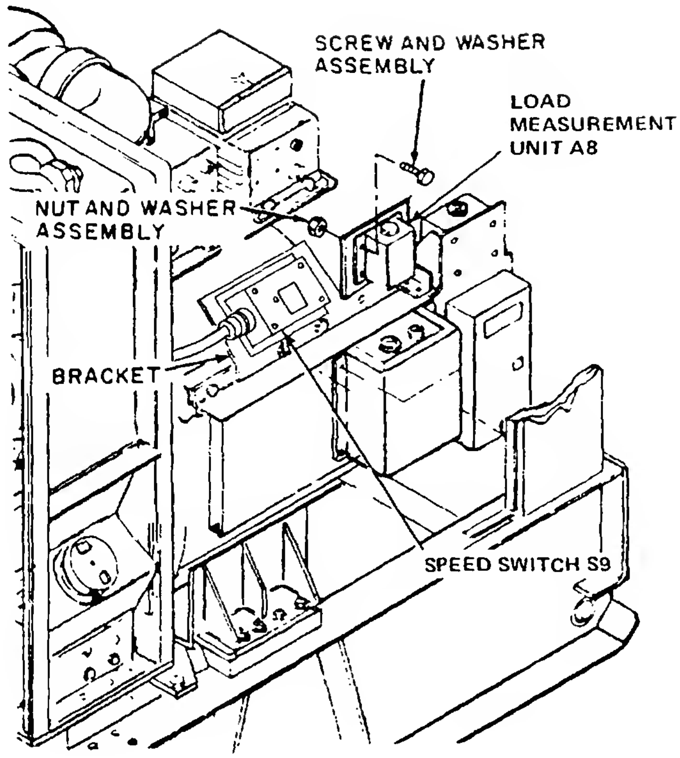


Figure 6-27. Load Measurement Unit A8, Removal and Installation

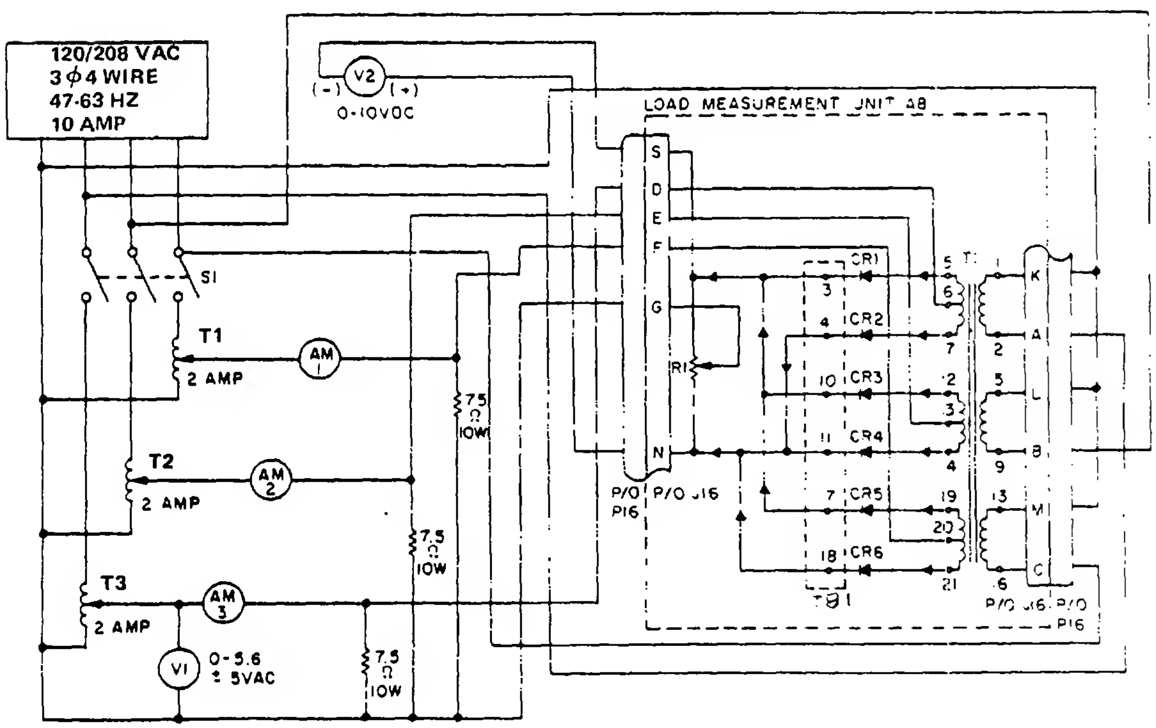


Figure 6-28. Load Measurement Unit A8, Test Setup

Table 6-7. Load Measurement Unit A8, Procedural Analysis

STEP	TEST CONDITION	REQUIRED RESULT	PROBABLE CAUSE FOR IMPROPER RESULT	CHECK OUT PROCEDURE
1.	Turn on the 120/208 V ac power supply with switch S1 open.	Voltmeter V2 should indicate from 0 to 0.4 V dc. Voltmeter V1 should indicate 0 V ac.	Resistor R1 not adjusted.	Adjust resistor R1 to obtain required result.
			Defective resistor R1, transformer T1, or diodes CR1 through CR6.	Check components with ohmmeter.
2.	Close switch S1 and adjust autotransformers T1, T2, and T3 so that AM1, 2, and 3 indicate 0.60 amps.	Voltmeter V1 should indicate 5.6 V ac. Voltmeter V2 should indicate 9.4 to 9.8 V dc.	Resistor R1 not adjusted.	Adjust R1 to obtain result.
			Defective resistor R1, transformer T1, or diodes CR1 through CR6.	Check components with ohmmeter.

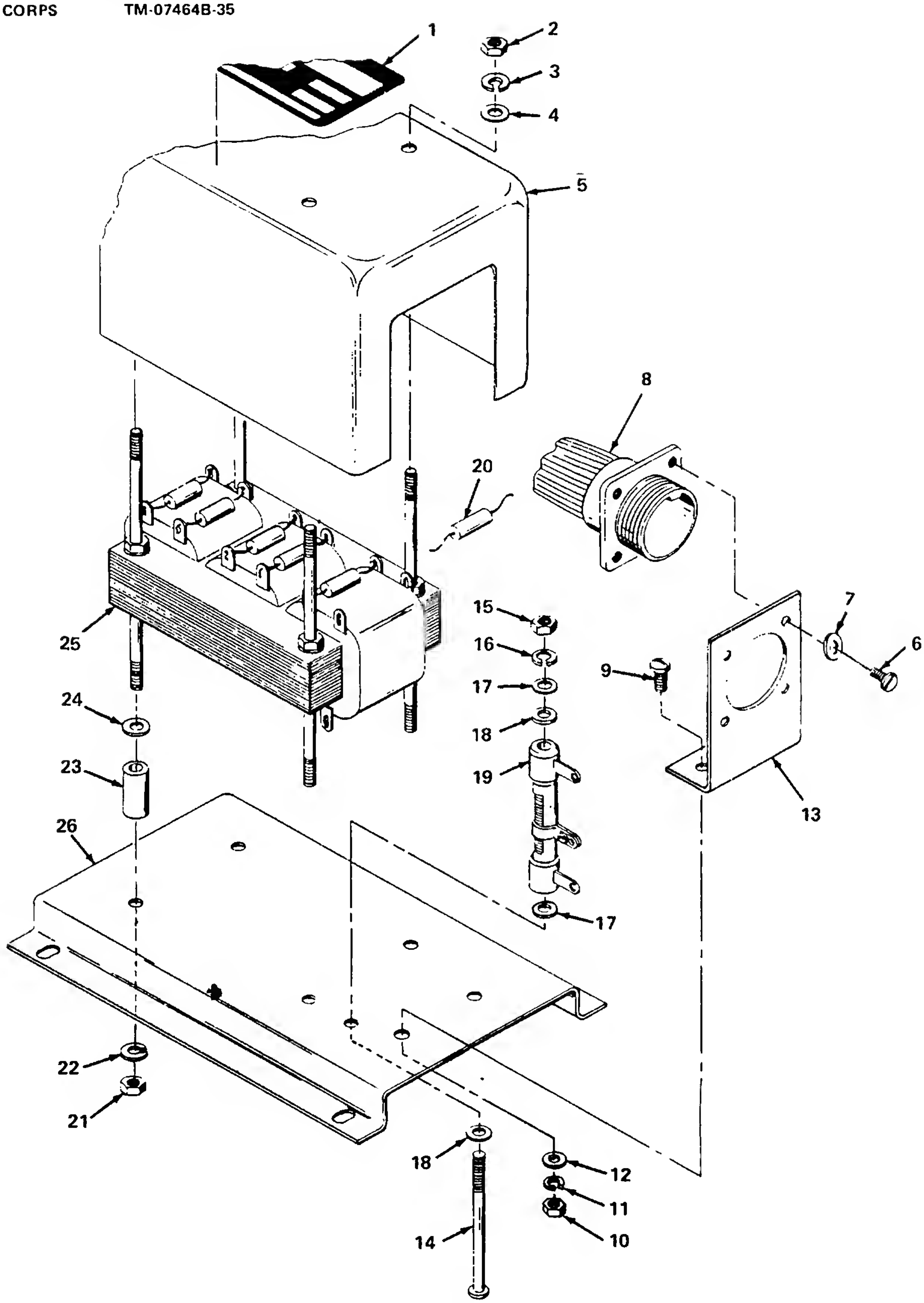


Figure 6-29. Load Measurement Unit A8, Exploded View (Sheet 1 of 2)

1. NAMEPLATE
2. NUT
3. LOCKWASHER
4. WASHER
5. COVER
6. SCREW
7. WASHER
8. RECEPTACLE (J16)
9. SCREW
10. NUT
11. LOCKWASHER
12. WASHER
13. BRACKET
14. SCREW
15. NUT
16. LOCKWASHER
17. WASHER
18. WASHER
19. ADJUSTABLE RESISTOR (R1)
20. DIODE (CR1 THROUGH CR6)
21. NUT
22. LOCKWASHER
23. TUBE
24. WASHER
25. TRANSFORMER (T1)
26. BRACKET

Figure 6-29. Load Measurement Unit A8, Exploded View (Sheet 2 of 2)

b. To free receptacle J16 (8), remove four screws (6) and four lockwashers (7).

c Receptacle mounting bracket (13) is held in place by two screws (9), two nuts (10), two lockwashers (11), and two washers (12).

d. To remove resistor (19), remove screw (14), washers (17 and 18), nut (15), and lockwasher (16).

e. To remove transformer T1 (25), remove four nuts (21) and four lockwashers (22).

f. Tape four spacers (23) to mounting stud of transformer (25) to prevent their loss.

6-60. REPAIR. Repairing the LMU consists of replacing defective electrical components (refer to paragraph 6-59 on disassembly).

CAUTION

Do not use excessive heat when removing diodes; use a heat sink.

6-61. REASSEMBLY. To reassemble LMU refer to figure 6-29 and proceed as follows:

a. Secure transformer (25) to bracket (26) with four nuts and lockwashers (21 and 22). Make certain four spacers and washers (23 and 24) are in place before placing transformer onto bracket.

b. Insert screw (14) with washer (18) over it, into appropriate bracket hole

c. Place washer (17), resistor (19), washers (17 and 18), and lockwasher (16) over screw (14).

d. Secure resistor (19) into place with nut (15).

e. Secure receptacle (8) to bracket (13) with four screws (6) and washers (7) and the bracket (13) to bracket (26).

f. Place cover (5) over studs of transformer (25) and secure in place with four washers, lockwashers, and nuts (4, 3, and 2).

6-62. INSTALLATION. To install LMU, refer to figure 6-27 and proceed as follows:

a. Secure LMU in place on mounting bracket with four screw and washer assemblies and four nut and washer assemblies.

b. Connect receptacle P16 to LMU and lock in place.

Section IX. WIRING HARNESS

6-63. GENERAL. Electrical interconnection of control devices and indicators is accomplished through wiring harnesses. Wires in the harnesses are bundled and secured to prevent unnecessary movement and chafing, and to conserve space. Internal wiring harnesses for the relay boxes, kits, and other electrical assemblies are also provided in this section.

6-64. REMOVAL AND INSPECTION. Refer to the Operator and Organizational Maintenance Manual for harness removal and inspection procedures.

6-65. REPAIR. Repair procedures for individual wires are covered in the Operator and Organizational Maintenance Manual.

6-66. REBUILD. If a wiring harness has sustained damage to 30 percent or more of the wires in the harness, the wiring harness must be completely rebuilt.

a. Refer to figures 6-30 through 6-34 and FO-7 and FO-8 for illustrations of the interconnecting wiring harnesses installed in the generator set ac electrical system.

b. Each illustration includes a wire run list providing wire origin, destination, identification number, wire length, and preparation requirements, and end preparation.

c. Refabricate a new wire harness using the appropriate illustration for dimensions and the wire run list for proper wire connection.

d. If a wiring harness cannot be identified, compare it with the illustrations until proper identification is made. Check numbers stamped on wires against those in the wire run list to ensure proper identification before proceeding with refabrication.

e. Wiring shall be neatly laced through the use of self-locking nylon straps, located at intervals not to exceed three inches, and also at each wire break out.

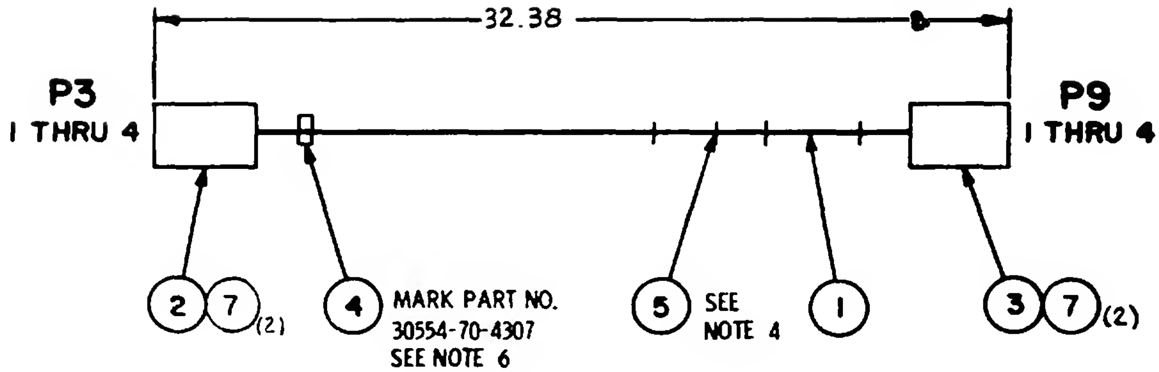
f. Soldering shall be in accordance with requirement 5 of MIL-STD-454 using SN60 solder.

g. Wire numbering shall be in accordance with MIL-W-5088, except that length between adjacent groups of numbers shall not exceed 6 inches.

h. Cut insulation tubing in 1/2 inch (12.7 mm) pieces and install around wires at pins of connectors and receptacles.

i. Install nylon filler plugs MS25251-16 in unused openings of connectors.

6-67. INSTALLATION. Refer to the Operator and Organizational Maintenance Manual for installation procedures.



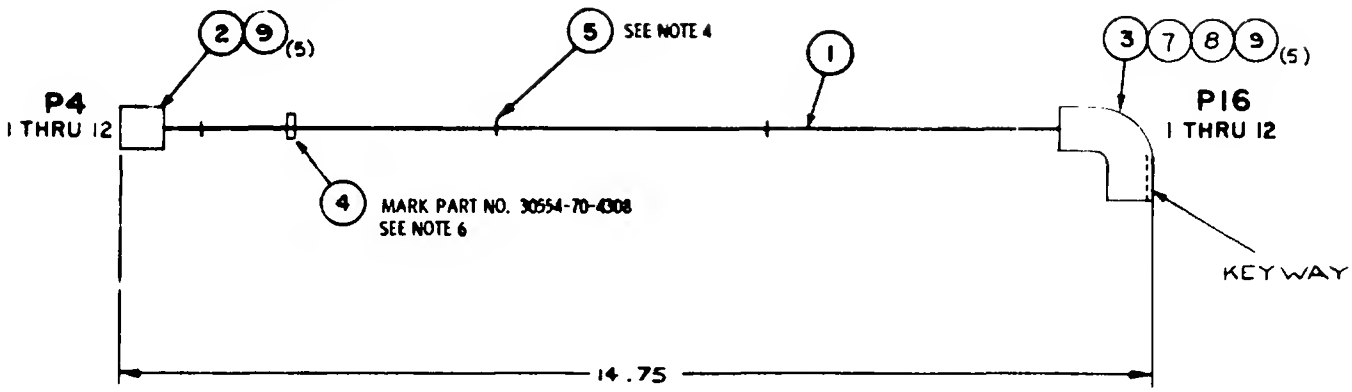
WIRE NO	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERMN FIND NO	TO	TERMN FIND NO.	LG REF
1	BLACK	X91D15	P3-A	2	P9-A	3	29.75
2	BLACK	X197B16	P3 B		P9-B		29.75
3	RED	P42B16	P3-C		P9-C		29.75
4	RED	P67B16	P3-D	2	P9-D	3	29.75

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

NOTES:

1. INTERPRET DRAWING PER MIL-STD-100.
2. ALL CONDUCTOR ENDS TO BE STRIPPED BACK 0.25 INCH AND TINNED BEFORE ASSEMBLY.
3. USE SOLDER, FIND NO. 6. SOLDER CONNECTIONS PER MIL-STD-454, REQT 5
4. CABLE STRAPS, FIND NO. 5, SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
5. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 INCHES.
6. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

Figure 6-30. Mode I Relay Box A27 to Exciter-Regulator A11, Wiring Harness

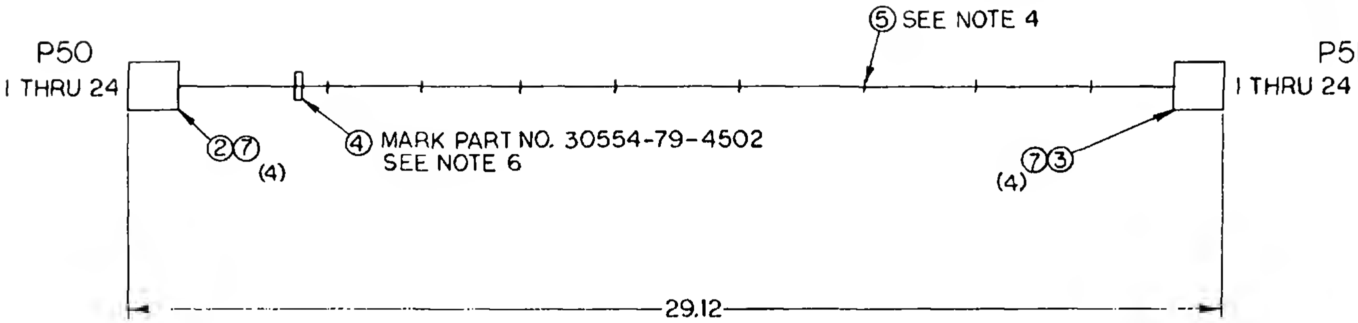


WIRE NO	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERMN FIND NO	TO	TERMN FIND NO.	LS REF
1	BLACK	X7L16	P4-A	2	P16-A	3	14.00
2	BLACK	X8L16	P4-B		P16-B		14.00
3	BLACK	X9Z16	P4-C		P16-C		14.00
4	BLACK	X115A16	P4-D		P16-D		14.00
5	BLACK	X116A16	P4-E		P16-E		14.00
6	BLACK	X117A16	P4-F		P16-F		14.00
7	BLACK	D24K16	P4-G		P16-G		14.00
8	BLACK	X12JJ16	P4-K		P16-K		14.00
9	BLACK	X12LL16	P4-L		P16-L		14.00
10	BLACK	X12EE16	P4-M		P16-M		14.00
11	BLACK	K101A16	P4-N		P16-N		14.00
12	BLACK	K102A16	P4-S	2	P16-S	3	14.00

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	0	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

NOTES:
1. INTERPRET DRAWING PER MIL-STD-100.
2. ALL CONDUCTOR ENDS TO BE STRIPPED BACK 0.25 INCH AND TINNED BEFORE ASSEMBLY.
3. USE SOLDER, FIND NO. 6. SOLDER CONNECTIONS PER MIL-STD-454, REQT 5
4. CABLE STRAPS, FIND NO. 5, SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
5. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 INCHES.
6. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.

Figure 6-31. Tactical Relay Box A29 to Load Measuring Unit A8, Wiring Harness



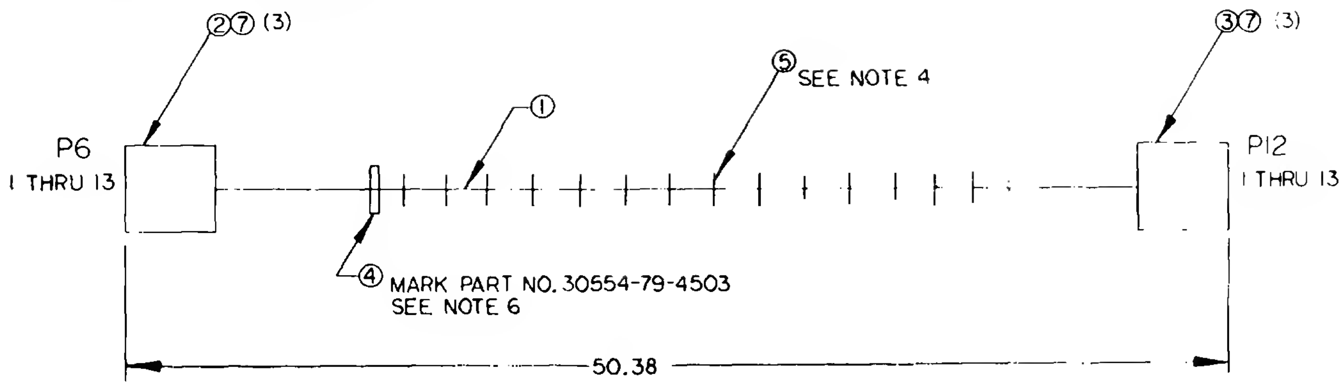
WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERMN FIND NO.	TO	TERMN FIND NO.	LG REF.
1	RED	P58C16	P50-A	2	P51-A	3	26.50
2	RED	P50S16	P50-B		P51-B		26.50
3	RED	P206C16	P50-C		P51-C		26.50
4	RED	P205C16	P50-D		P51-D		26.50
5	RED	P60B16	P50-E		P51-E		26.50
6	RED	P203C16	P50-F		P51-F		26.50
7	RED	P209C16	P50-G		P51-G		26.50
8	RED	P62J16	P50-H		P51-H		26.50
9	BLACK	X9U16	P50-J		P51-J		26.50
10	BLACK	X12BB16	P50-K		P51-K		26.50
11	RED	P50AK16	P50-L		P51-L		26.50
12	RED	P55Z16	P50-M		P51-M		26.50
13							
14	RED	P200T16	P50-P		P51-P		26.50
15	BLACK	X8J16	P50-R		P51-R		26.50
16	BLACK	X7J16	P50-S		P51-S		26.50
17	BLACK	X17D16	P50-T		P51-T		26.50
18	BLACK	X18D16	P50-U		P51-U		26.50
19	BLACK	X19D16	P50-V		P51-V		26.50
20	RED	P558C16	P50-W		P51-W		26.50
21							
22	RED	P63B16	P50-a		P51-a		26.50
23	RED	P62E16	P50-b		P51-b		26.50
24	BLACK	D24E16	P50-d	2	P51-d	3	26.50

WIRE LENGTH TOLERANCES		
OVER	INCL	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

NOTES:

1. INTERPRET DRAWING PER MIL-STD-100.
2. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
3. USE SOLDER, FIND NO.6. SOLDER CONNECTIONS PER MIL-STD-454, REQT 5.
4. CABLE STRAPS, FIND NO. 5 SHALL BE SPACED AT APPROX 3.00 APART UNLESS OTHERWISE SPECIFIED.
5. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-M-5088 EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
6. PART NO MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.
7. INSTALL NYLON FILLER PLUGS (FIND NO. 7) IN UNUSED OPENINGS OF CONNECTOR BUSHING

Figure 6-32. Mode I Relay Box A27 to Tactical Relay Box A29, Wiring Harness



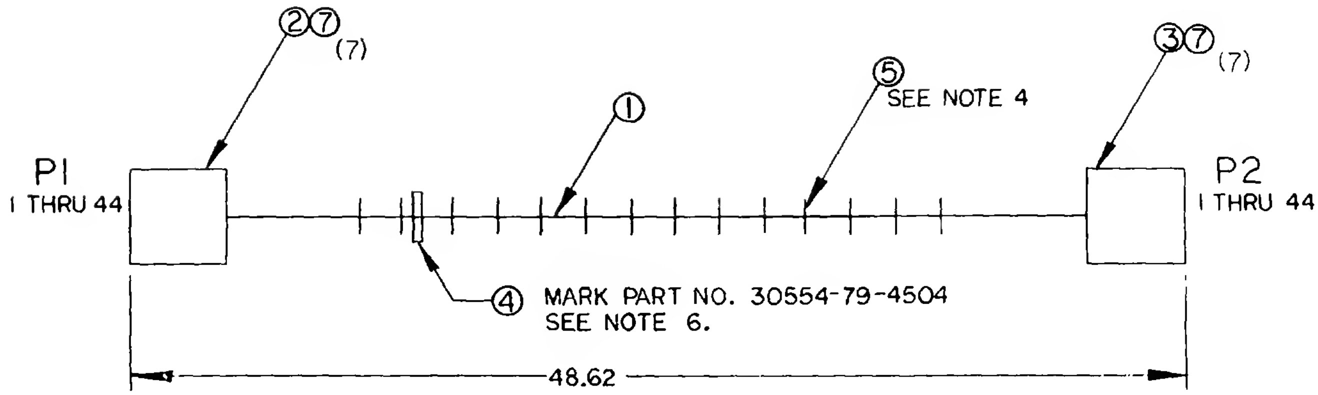
WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERMN FIND NO.	TO	TERMN FIND NO.	LG REF
1	RED	P45K16	P6-A	2	P12-A	3	48.00
2	RED	P66A16	P6-B		P12-B		48.00
3	RED	P200A16	P6-C		P12-C		48.00
4	RED	P201A16	P6-D		P12-D		48.00
5	RED	P202A16	P6-E		P12-E		48.00
6	RED	P203A16	P6-F		P12-F		48.00
7							
8	RED	P205A16	P6-H		P12-H		48.00
9	RED	P206A16	P6-I		P12-I		48.00
10	RED	P207A16	P6-K		P12-K		48.00
11	RED	P208A16	P6-L		P12-L		48.00
12	RED	P209A16	P6-M	2	P12-M	3	48.00
13							

OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

NOTES:

1. INTERPRET DRAWING PER MIL-STD-100.
2. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
3. USE SOLDER, FIND NO. 6. SOLDER CONNECTIONS PER MIL-STD-454, REQ'T 5.
4. CABLE STRAPS FIND, NO. 5, SHALL BE SPACED AT APPROX. 3.00 APART
5. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-M-5088 EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 INCHES.
6. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.
7. INSTALL NYLON FILLER PLUGS (FIND NO. 7) IN UNUSED OPENINGS OF CONNECTOR BUSHINGS

Figure 6-33. Mode I Relay Box A27 to Fault Indicator Panel A29, Wiring Harness



NOTES:

1. INTERPRET DRAWING PER MIL-STD-100.
2. ALL CONDUCTOR ENDS TO BE STRIPPED BACK .25 INCH AND TINNED BEFORE ASSEMBLY.
3. USE SOLDER, FIND NO. 6, SOLDER CONNECTIONS PER MIL-STD-454, REQ'T 5.
4. CABLE STRAPS, FIND NO. 5, SHALL BE SPACED AT APPROX. 3.00 APART UNLESS OTHERWISE SPECIFIED.
5. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088 EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 IN.
6. PART NO. MARKING TO BE METAL STAMPED IN ACCORDANCE WITH MIL-STD-130.
7. INSTALL NYLON FILLER PLUGS (FIND NO. 7) IN UNUSED OPENINGS OF CONNECTOR BUSHINGS.

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

Figure 6-34. Mode I Relay Box A27 to Control Cubicle A3, Wiring Harness (Sheet 1 of 2)

WIRE NO.	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERMN FIND NO.	TO	TERMN FIND NO.	LG. REF.
1	BLACK	D20C16	P1-A	2	P2-A	3	46.00
2	BLACK	D21C16	P1-B		P2-B		46.00
3	BLACK	D22C16	P1-C		P2-C		46.00
4	BLACK	D24C16	P1-D		P2-D		46.00
5	BLACK	X7C16	P1-E		P2-E		46.00
6	BLACK	X8C16	P1-F		P2-F		46.00
7	BLACK	X14C16	P1-G		P2-G		46.00
8	BLACK	X15C16	P1-H		P2-H		46.00
9	BLACK	X16C16	P1-I		P2-I		46.00
10	BLACK	L25B16	P1-J		P2-J		46.00
11	BLACK	L26B16	P1-K		P2-K		46.00
12	BLACK	X91B16	P1-L		P2-L		46.00
13							
14							
15	BLACK	X31B16	P1-O		P2-O		46.00
16	BLACK	X194B16	P1-P		P2-P		46.00
17	RED	P45F16	P1-R		P2-R		46.00
18	BLACK	X29B16	P1-S		P2-S		46.00
19							
20	BLACK	X90C16	P1-U		P2-U		46.00
21	RED	E39B16	P1-V		P2-V		46.00
22	RED	E38B16	P1-W		P2-W		46.00
23	RED	E37B16	P1-X		P2-X		46.00
24	RED	E35B16	P1-Y		P2-Y		46.00
25	RED	E36B16	P1-Z		P2-Z		46.00
26	RED	P199B16	P1-a		P2-a		46.00
27							
28	RED	P198B16	P1-c		P2-c		46.00
29	RED	P47C16	P1-d		P2-d		46.00
30	BLACK	X195B16	P1-e		P2-e		46.00
31	RED	P44C16	P1-f		P2-f		46.00
32	RED	P62C16	P1-g		P2-g		46.00
33	RED	P56C16	P1-h		P2-h		46.00
34	RED	P80D16	P1-k		P2-k		46.00
35	BLACK	X197B16	P1-m		P2-m		46.00
36	RED	P55LL16	P1-n		P2-n		46.00
37	RED	P55X16	P1-p		P2-p		46.00
38	RED	P57D16	P1-r		P2-r		46.00
39	RED	P40M16	P1-t		P2-t		46.00
40	RED	P40L16	P1-u		P2-u		46.00
41	RED	P50J16	P1-v		P2-v		46.00
42	RED	P46B16	P1-w		P2-w		46.00
43	BLACK	X12C16	P1-x		P2-x		46.00
44	BLACK	X9C16	P1-y	2	P2-y	3	46.00

Figure 6-34. Mode I Relay Box A27 to Control Wiring Harness (Sheet 2 of 2)

CHAPTER 7

MAINTENANCE OF FUEL SYSTEM

Section I. MAINTENANCE OF DAY TANK ASSEMBLY

7-1. GENERAL. The day tank is mounted on the unit lifting frame and is located on the left side of the engine. The day tank is non-pressurized and provides a gravity head of fuel to the fuel injection pump. The day tank is equipped with a fuel level switch, a solenoid valve assembly, a diode assembly, a drain cock, a vent, an excessive fuel return port, fuel inlet port, and a fuel outlet port. The fuel level switch is of the dual float type. The upper float senses fuel level and prevents the overflow of fuel. The lower float senses fuel level and opens a circuit breaker to stop the engine after the fuel supply to the day tank has been shut off for 4 minutes. The solenoid valve assembly opens the fuel supply line when the generator set is started. The diode assembly reduces transient radio interference generated by the solenoid valve during operation. The drain cock provides a means to drain the day tank. The vent prevents the system from becoming air bound. The day tank has a usable fuel capacity sufficient for a minimum of 5 minutes operation at rated load, after the fuel supply to the tank has been shut off.

7-2. REPAIR.

a. Removal and Disassembly.

(1) Refer to the Operator and Organizational Maintenance Manual and remove ether tank, ether cylinder bracket, radio suppression diode assembly, and fuel solenoid valve.

(2) Refer to figure 7-1 and remove cap (16), open valve (15), and drain fuel into a container.

(3) Tag hoses (2, 3, 4, and 5) and note positions of elbows (11, 12, 13, and 14). Tag, remove, and plug hoses and elbows.

(4) Disconnect electrical connector (1) from fuel level switch (10)

(5) Remove bolts (8), washers (7), and nuts (6) that secure day tank (9) to lifting frame. Remove tank

(6) Remove fuel level float switch (10).

b. Cleaning.

see OB-1 del

WARNING

~~Cleaning solvent trichloroethane (Tri-ethane) 1.1.1 (MIL-T-81533A) is flammable and toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory tract protection is required.~~

del. ins (1) ~~Clean fuel level switch with tri-ethane 1.1.1~~ (MIL-T-81533A).

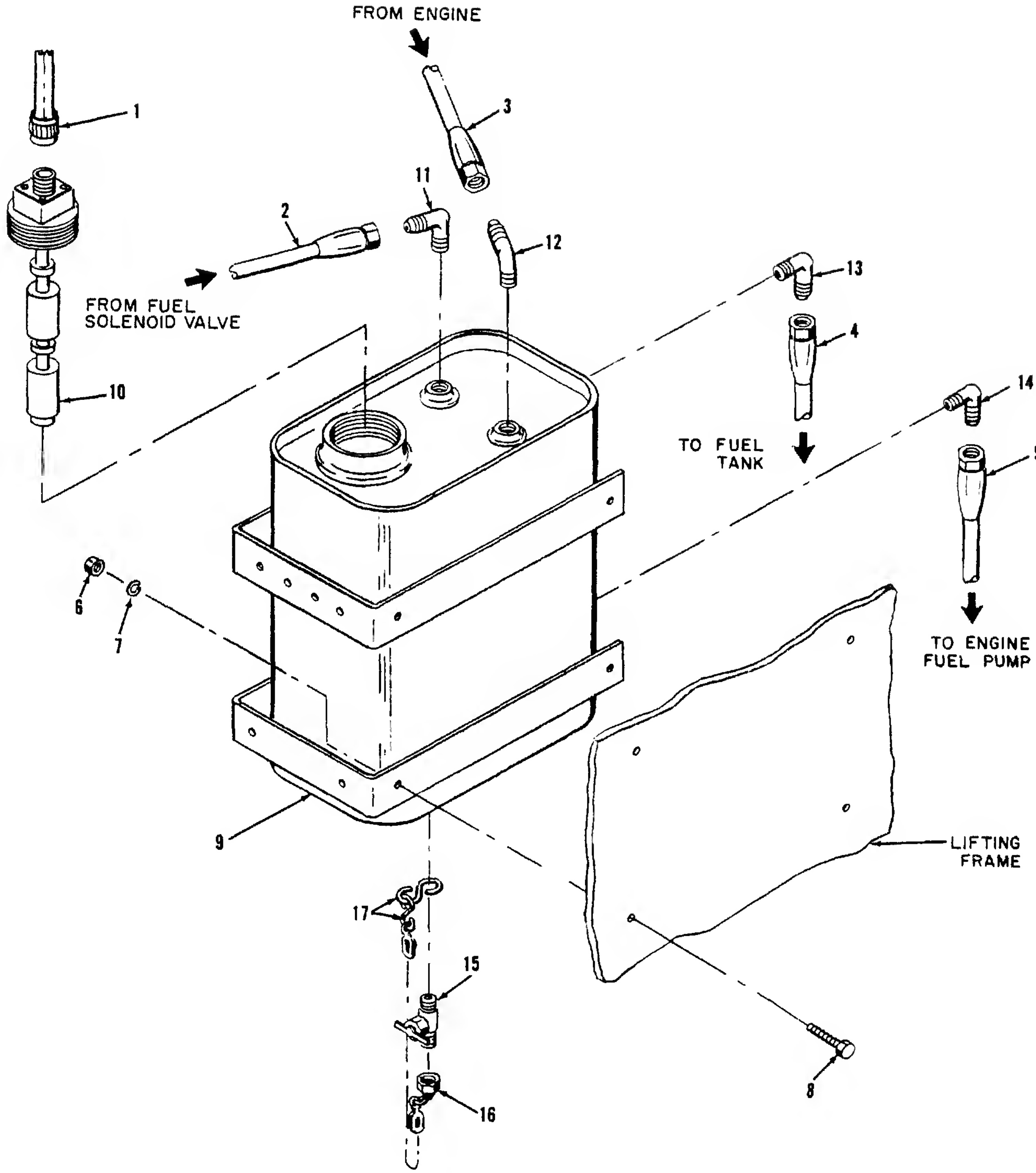
(2) Clean day tank with clean fuel. Flush out oil, sediment, and dry tank thoroughly.

c. Inspection.

(1) Test fuel level switch. Refer to the Operator and Organizational Maintenance Manual.

(2) Inspect threaded components for stripped, crossed, or damaged threads.

(3) Plug openings in day tank and apply 1 psi (6.89 kPa) air pressure. Submerge tank in water and observe for air bubbles which are indicative of leaks. Mark damaged areas.



1. ELECTRICAL CONNECTOR
2. HOSE
3. HOSE
4. HOSE
5. HOSE
6. NUT
7. WASHER
8. BOLT
9. DAY TANK
10. FLOAT SWITCH
11. ELBOW
12. ELBOW
13. ELBOW
14. ELBOW
15. DRAIN VALVE
16. CHAIN AND CAP
17. CHAIN HOOK

Figure 7-1. Day Tank, Exploded View

d. Repair.

WARNING

Do not weld fuel tank unless it has been steam cleaned and filled with water.

WARNING

Steam or vapor pressure cleaning creates hazardous noise levels and severe burn potential. Skin, eye, and ear protection is required.

(1) Steam clean tank and fill with water.

WARNING

Welding operations produce heat, highly toxic fumes, injurious radiation, metal slag, sand airborne particles. Welding goggles, the proper tinted lenses, apron or jacket, and welder's boots are required.

(2) Repair leaks by welding.
(3) Recheck tank for leaks after welding.
(4) Repair minor thread damage using a thread chaser.

WARNING

Paint is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

(5) Scrape paint off damaged area, prime, and repaint as necessary using olive drab, per MIL-T-704, Type A, semi-gloss, No. X24087.

7-3. REPLACEMENT.

a. Replace defective fuel level float switch.
b. Replace damaged fittings.
c. Install repaired or replacement day tank on lifting frame using bolts (8), nuts (6), and washers (7).
d. Reconnect fuel lines.
e. Install radio suppression diode assembly, ether cylinder clamp, fuel solenoid valve, and ether cylinder on tank. Refer to the Operator and Organizational Maintenance Manual.

Section II. MAINTENANCE OF FUEL TANK ASSEMBLY

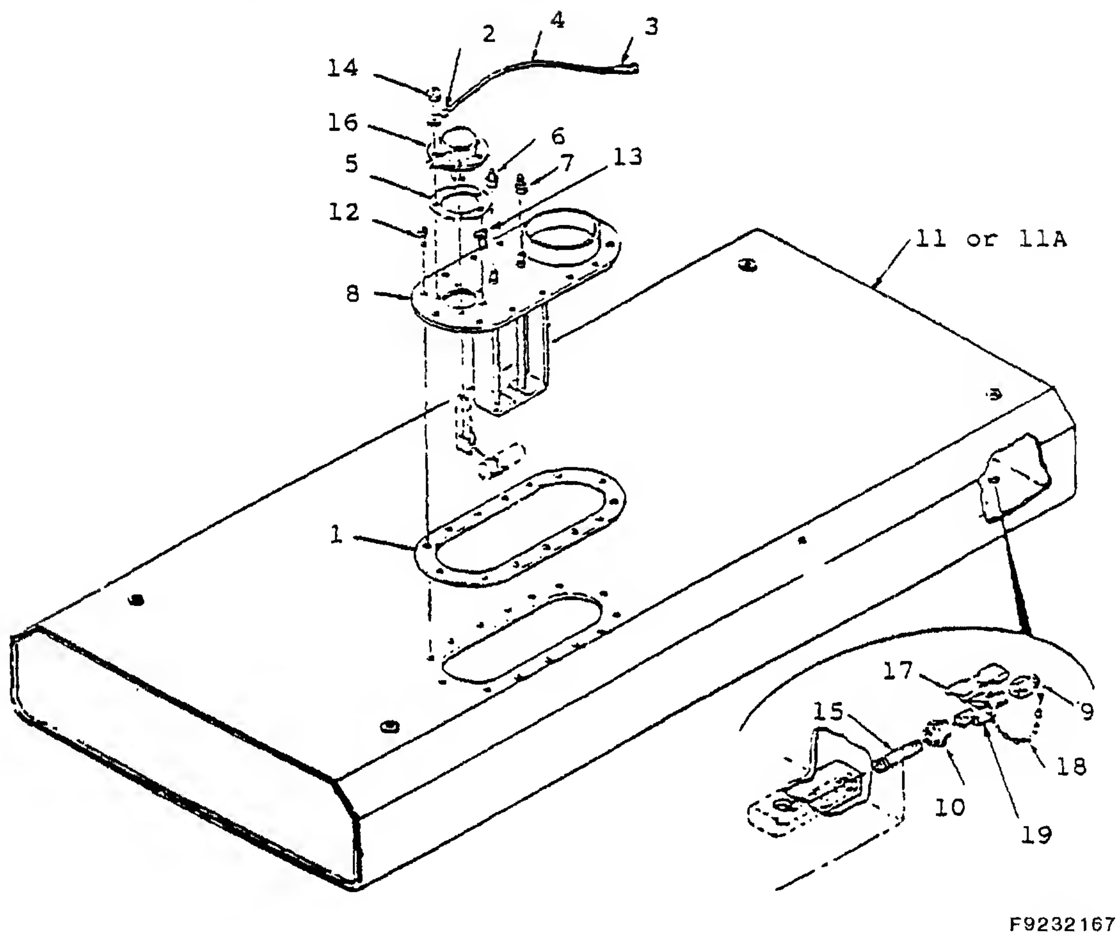
7-4. GENERAL. The baffled fuel tank which stores fuel for generator operation is located within the base assembly. Fuel tank components include a fuel level transmitter mounted on a plate assembly and a needle valve. The fuel level transmitter senses the fuel level in the tank and transmits a signal to the fuel level gage on the control cubicle. The gage indicates a reading corresponding to that of the transmitter. The needle valve permits draining of the fuel tank.

7-5. REPAIR.

a. Removal.
(1) Refer to the Operator and Organizational Maintenance Manual. Drain fuel tank, remove tool box and filler panels. Tag, disconnect, and cap fuel lines from the fuel tank.
(2) Refer to figure 12-1 and remove rear tank stops.
(3) Remove fuel filler hose which connects fuel tank to filler neck.

(4) Disconnect electrical connector from fuel level transmitter (12, figure 7-2).

(5) The fuel tank is secured to skid base by two straps. These straps are secured to the skid base (at four points just above the fork lift truck access ports) by T-bolts which are tightened by flat washers, bevel washers, and self-locking nuts. Loosen all four self-locking nuts until fuel tank is free to move.



1. Gasket
2. Lug
3. Lug
4. Wire
5. Gasket
6. Connector
7. Connector
8. Plate
9. Cap
10. Coupling

11/11A. Fuel Tank (Plastic or Steel)
12. Screw
13. Rivet
14. Screw-Washer
15. Nipple
16. Transmitter, Fuel level
17. Valve
18. Chain
19. Hook, Chain

Figure 7-2. Fuel Tank Assembly, Exploded View

(6) Remove fuel tank from the skid base through the tool box opening.

b. Disassembly. Refer to figure 7-2 and disassemble fuel tank as follows.

(1) Remove adapters (6 and 7) from plate (8).

(2) Remove screws (12) that attach plate (8) to fuel tank (11 or 11A). Remove plate with fuel level transmitter (16) and float.

(3) Match mark alignment on plate (8) and fuel tank (11 or 11A) to assure proper reassembly.

c. Cleaning.

(1) Remove gasket (1) with scraper.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye and respiratory protection is required.

(2) Clean parts and tank exterior with cleaning solvent (P-D-680, Type II).

(3) Clean interior of tank with clean fuel. Agitate tank to loosen sediment and pour fuel into a nonflammable container. Repeat procedure until all sediment is removed.

WARNING

Steam or vapor pressure cleaning creates hazardous noise levels and severe burn potential. Skin, eye, and ear protection is required.

(4) Steam clean tank if sediments cannot be removed by performing step (3), or if tank is to be repaired by welding.

(5) Clean old sealant from pipe threads with wire bruch.

d. Inspection.

(1) Shake transmitter float to check for fuel in float which would indicate a cracked or damaged float.

(2) Test fuel level transmitter. Refer to the Operator and Organizational Maintenance Manual.

(3) Check for leaks as follows:

(a) Plug all fuel tank openings except for one.

(b) Connect a low pressure regulated air supply to the remaining opening.

CAUTION

Do not apply more than 3 psi (20.67 kPa) pressure to fuel tank.

(c) Slowly apply 0.5 psi (3.45 kPa) air pressure to fuel tank.

(d) Apply soapy water solution to tank and check for bubbles that would indicate leaks. Mark leaks.

(e) Shut off and disconnect air supply from tank.

(f) Plug the opening port and connect a suitable pressure supply and gage to needle valve.

CAUTION

Do not apply more than 3 psi (20.67 kPa) pressure to fuel tank.

(g) Apply pressure and bleed test equipment by opening needle valve lightly.

(h) Gradually increase pressure to about 3 psi (20.67 kPa).

(i) Shut off pressure supply and check for leakage after an hour.

(j) If leakage is indicated on gage, apply soapy water solution to locate leakage on fuel tank. Mark leaking area.

(k) Disconnect gage and pressure supply from needle valve.

(4) Check transmitter float linkage for distortion.

(5) Check for damaged threads.

(6) Inspect paint for damage.

e. Repair of metal Fuel Tank.

WARNING

Do not weld fuel tank unless it has been steam cleaned and filled with water. Welding operations produce heat, highly toxic fumes, injurious radiation, metal slag, and airborne particles. Welding goggles, the proper tinted lenses, apron or jacket, and welders boots are required.

WARNING

Steam vapor pressure cleaning creates hazardous noise levels and severe burn potential. Skin, eye, and ear protection is required.

(1) Steam clean tank and fill with water.

(2) Weld cracks or holes. Repair large damaged areas with a patch.

(3) Drain water from tank and dry thoroughly.

(4) Leak test tank as specified in step d above.

(5) Straighten distorted transmitter float linkage.

(6) Repair damaged fuel tank threads using die. Fill cap grooves with grease to catch cuttings. Remove all cuttings from tank.

WARNING

Paint is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye and respiratory tract protection is required.

(7) Remove damaged paint with a scrapper. Blend in edges, prime, and paint damaged areas using olive drab, per MIL-T-706, Type A, semi-gloss, NO. X24807.

f. Reassembly.

(1) Install new gasket (5) on fuel tank (19).

(2) Align and install plate (4) on gasket (5) and fuel tank (19) and secure with screws (3).

(3) Apply thread sealing compound MIL-S-45180, Type III to pipe threads.

g. Installation.

(1) Install repaired or replacement fuel tank through tool box opening. Make sure that the needle valve is facing opening.

(2) Position and hold tank against forward stops and install rear tank stops and filler panels.

(3) Secure tank with fuel tank straps.

(4) Connect fuel and vent lines to tank.

(5) Connect electrical connector fuel tank level transmitter.

(6) Connect fuel filler hose to fuel tank and secure with clamp.

(7) Install tool box.

(8) Service fuel tank. Refer to the Operation and Organizational Maintenance Instructions.

7-5A. Repair of Plastic Fuel Tank P/N 90-4000.

(1) Steam clean tank.

(2) Clean the void or pin hole and the intermediate area, and be certain any contaminates are completely removed (use knife, razor knife and acetone).

(3) Position high intensity heat lamp (Smith Victor High Intensity Lamp, Model TL2, 600 watts with Sylvania bulb CVY rated at 650 watts, 120 volts or equivalent) approximately 6" from area to be filled and apply heat until heated area becomes translucent.

(4) Heat resin powder on putty knife until powder becomes partially melted, then force partially melted powder into void or hole while forcing out as much air as possible.

(5) Heat damaged area further (300°F-350°F) to force any further entrapped air out, use putty knife or 14-20 gauge solid wire. When area becomes light tan tint color remove heat source.

(6) Allow area to cool to ambient temperature, use abrasive paper 180-240 grit to smooth out filled surface.

(7) Return tank to leak testing (Paragraph d.3).

NOTE

For reassembly and installation refer to paragraphs 7-5, f and g.

Section III. MAINTENANCE OF FUEL INJECTION PUMP

7-6. GENERAL. The generator set uses a pressure type fuel system. An individual fuel injection pump and an injection valve are provided for each of the six cylinders. The fuel injection pumps are located in the fuel injection pump housing on the right side of the engine. The priming pump and fuel transfer pump supply fuel from the day tank to the injection pump housing. The injection pump housing manifold distributes fuel, under the pressure from the priming or fuel pumps, to each of the six fuel injection pumps. The amount of fuel pumped per stroke of each fuel injection pump is controlled by the position of a sleeve on the pump plunger. This position is regulated by the governor. The fuel injection pump plungers and lifters are actuated by the lobes on the fuel injection pump camshaft.

NOTE

The fuel system should be bled after maintenance or inspections have been performed on components of the fuel system located after the day tank or whenever air is trapped in the fuel system.

7-7. REMOVAL OF FUEL INJECTION PUMP HOUSING.

NOTE

Before removing fuel injection pumps and fuel transfer pump, an on-equipment test can be performed to isolate a cylinder which is misfiring or running rough, and causing black smoke in the exhaust. This test cannot determine if the fuel injection pump or injection valve is at fault. Refer to paragraph 7-20 for this on-equipment test.

a. Refer to the Operator and Organizational Maintenance Manual and remove the alternator belt, governor, and governor drive adapter.

b. Number one cylinder should be placed Top Dead Center (TDC) on compression stroke by aligning slot on fuel pump camshaft (refer to figure 7-8).

c. Refer to paragraph 11-39, step d, and remove the fuel injection pump drive gear cover.

NOTE

If the drive gear (6, figure 7-3) does not loosen from the camshaft when struck, use a puller to remove drive gear (6).

d. Loosen bolt (1) which secures drive gear (6) to the fuel injection pump camshaft. Strike bolt (1) with a hammer to loosen gear (6) from the camshaft. Remove bolt (1) and washer (2). If necessary, use a suitable puller to loosen drive gear (6).

e. Refer to the Operator and Organizational Maintenance Manual and remove the fuel injection lines, fuel supply line, and fuel return line from the fuel injection pump housing (7).

f. Disconnect bleed line (3) and transfer pump drain line (4).

g. Remove nuts (5) and remove fuel injection pump housing (7) from the engine. Remove fuel injection pump drive gear (6) from housing (7).

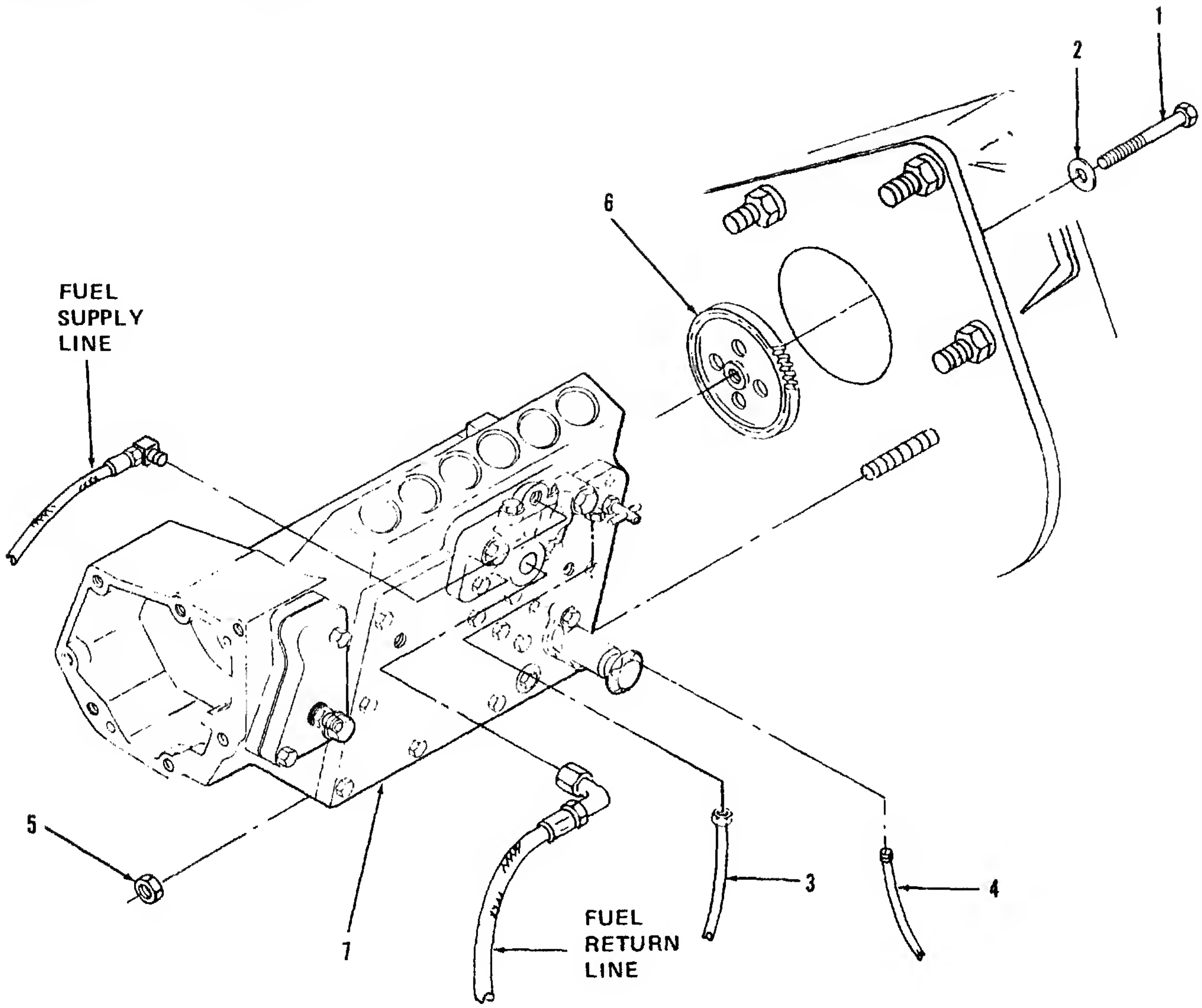
7-8. REMOVAL AND DISASSEMBLY OF FUEL INJECTION PUMPS.

a. Remove bolts (1 and 3, figure 7-4) and washers (2 and 4) to remove priming pump assembly (5) and gasket (6).

b. Remove bolts (7 and 8).

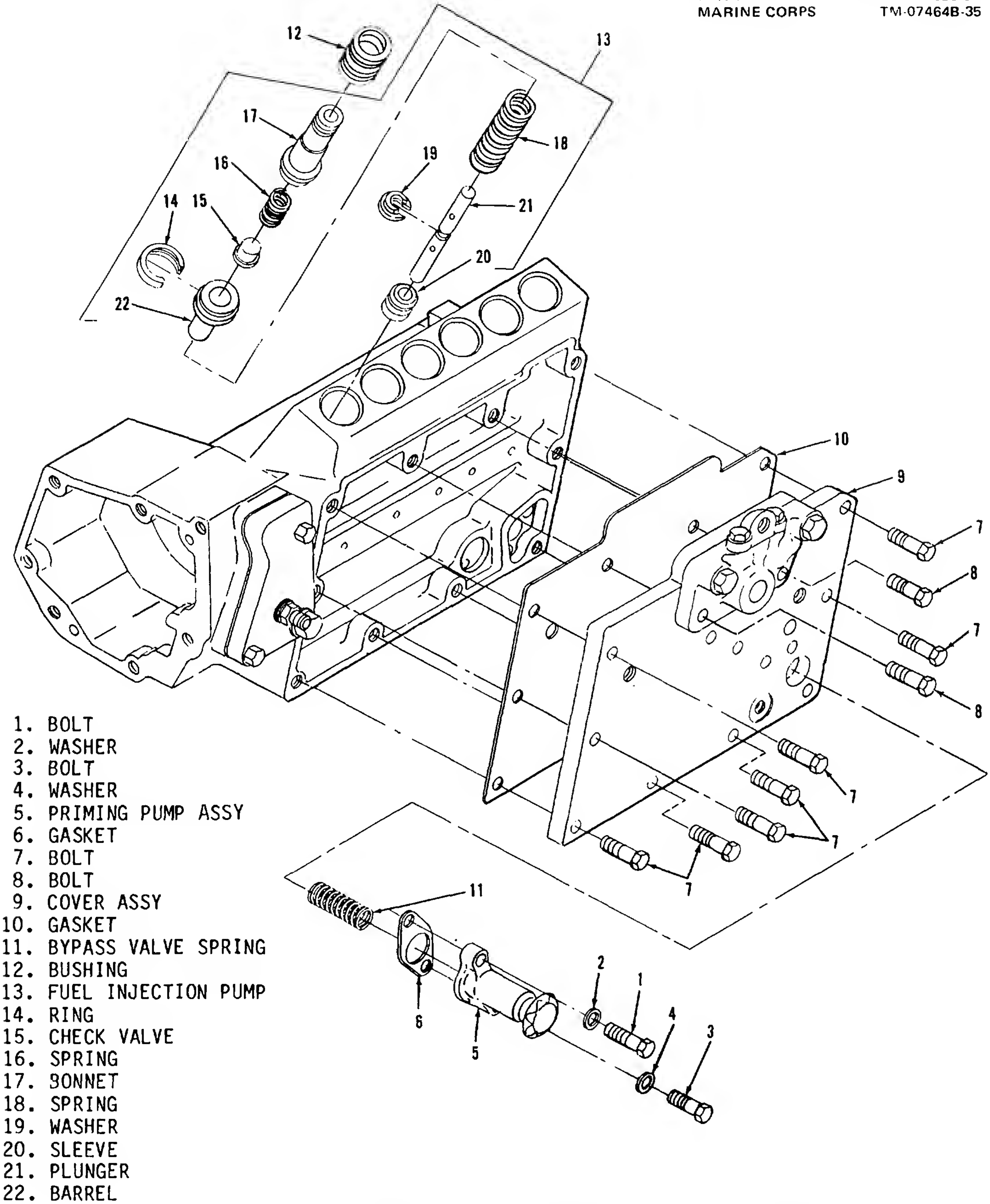
c. Remove cover assembly (9) and gasket (10).

d. Remove bypass valve spring (11).



1. BOLT
2. WASHER
3. BLEED LINE
4. DRAIN LINE
5. NUT
6. FUEL INJECTION PUMP DRIVE GEAR
7. FUEL INJECTION PUMP HOUSING

Figure 7-3. Fuel Injection Pump Housing, Removal and Installation



1. BOLT
2. WASHER
3. BOLT
4. WASHER
5. PRIMING PUMP ASSY
6. GASKET
7. BOLT
8. BOLT
9. COVER ASSY
10. GASKET
11. BYPASS VALVE SPRING
12. BUSHING
13. FUEL INJECTION PUMP
14. RING
15. CHECK VALVE
16. SPRING
17. BONNET
18. SPRING
19. WASHER
20. SLEEVE
21. PLUNGER
22. BARREL

Figure 7-4. Removal and Disassembly of Fuel Injection Pumps

e. Loosen bushing (12) to remove fuel injection pump (13) and bushing (12).

f. Remove bushing (12) from fuel injection pump (13).

NOTE

Keep component parts of each fuel injection pump together for reassembly. Do not intermix component parts of different pumps. If damaged or defective, plunger and barrel must be replaced as a matched set, and cannot be replaced individually.

g. Remove ring (14).

h. Remove check valve (15) and spring (16) from bonnet (17).

i. Remove spring (18) and washer (19).

j. Remove sleeve (20) and plunger (21) from barrel (22).

7-9. REMOVAL AND DISASSEMBLY OF FUEL PUMP.

a. Remove the fuel injection pump housing in accordance with paragraph 7-7.

b. Position the fuel injection pump housing on a working fixture or stand.

c. Install timing pin (see figure 7-8) to keep the injection pump camshaft from turning during disassembly and reassembly.

d. Install a 3/4-16 x 120 bolt (Special Tool 2H3740, refer to table 2-1) into threads of sleeve (1, figure 7-5). Tighten the bolt until sleeve (1) can be removed. Do not strike bolt or sleeve.

e. Remove bolts (2) which secure the fuel pump body (10) to the fuel injection pump housing. Remove the fuel pump body from the fuel injection pump housing.

f. Remove idler gear (3), seal ring (4), and seals (5 and 6).

g. Remove dowel (7), shaft (8), and fuel pump drain fitting (9) from the fuel pump body (10).

h. Remove drive gear (11) and key (12) from fuel injection pump camshaft.

7-10. DISASSEMBLY OF FUEL INJECTION PUMP HOUSING.

a. Remove fuel injection pump housing in accordance with paragraph 7-7.

b. Remove fuel injection pumps in accordance with paragraph 7-8.

c. Remove the fuel pump from the fuel injection pump housing in accordance with paragraph 7-9.

d. Disassemble cover assembly (9, figure 7-4) as follows (see figure 7-6):

(1) Remove bolts (1), elbow (2), gasket (3), and gasket (5).

(2) Remove bolts (4) which secure the siphon break housing (7). Remove the gasket (5) from the housing (7).

(3) Remove bolts (8) to remove fuel channel (9).

(4) Remove fitting (10), plug (11), seal (12), and plug (13) from the fuel injection pump housing cover (14).

e. Refer to figure 7-7 and remove bolts (1) to remove torque spring cover assembly (2).

f. Remove bolt (3) and seal (4).

g. Remove nut (5), lockwasher (6), washers (7 and 8), screw assembly (9), and gasket (10) from torque spring cover (11).

h. Remove bypass valve (12) and check valve (13).

i. Remove pin (14) and seal rings (15 and 16).

j. Remove shaft (20).

k. Loosen screws (18) to free the levers (19) from the sleeve control shaft assembly (17). Remove sleeve control shaft assembly (17).

l. Remove screws (18) and levers (19).

m. Remove lifters (21) and rollers (22). Tag all lifters and rollers to ensure correct reassembly.

n. Slide fuel injection pump camshaft (23) from housing assembly (28).

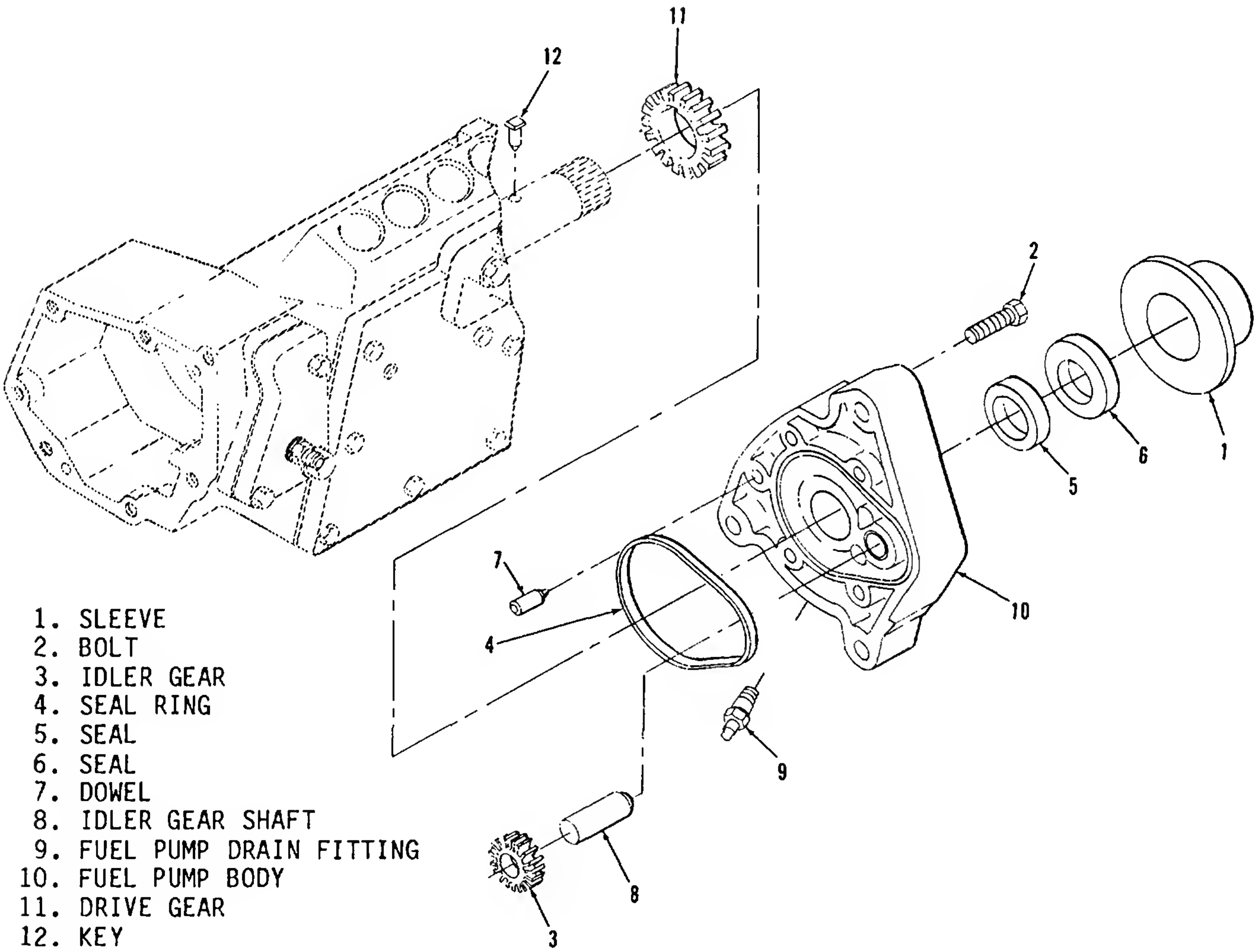
o. Remove pin (24) and stud (25) from housing assembly (28).

p. Remove dowel (26) and seal (27) from housing assembly (28).

NOTE

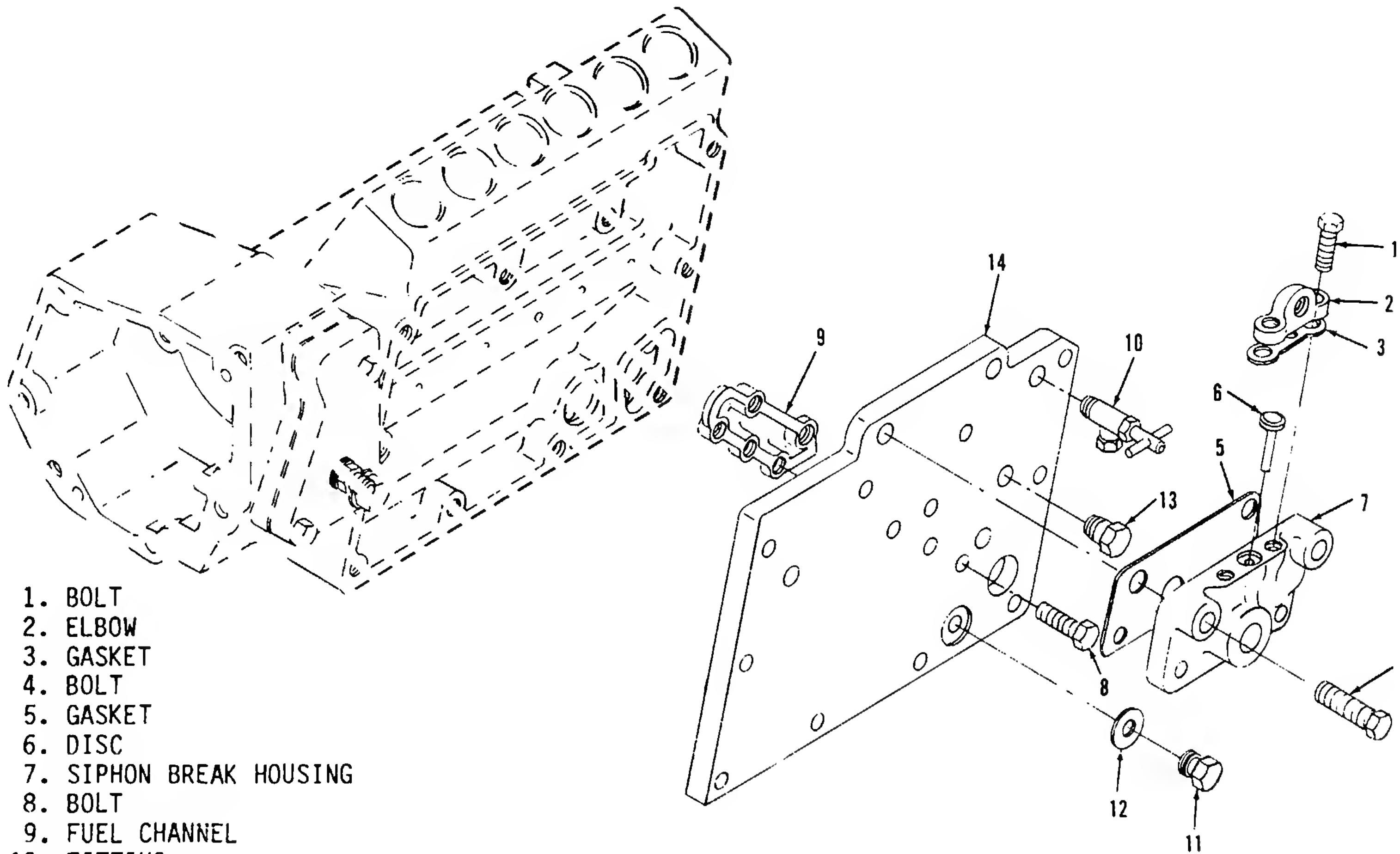
Bearings (29 and 30) must be replaced if damaged.

q. If replacement of the bearings is required, drive bearings (29 and 30) from housing (31).



1. SLEEVE
2. BOLT
3. IDLER GEAR
4. SEAL RING
5. SEAL
6. SEAL
7. DOWEL
8. IDLER GEAR SHAFT
9. FUEL PUMP DRAIN FITTING
10. FUEL PUMP BODY
11. DRIVE GEAR
12. KEY

Figure 7-5. Fuel Pump, Exploded View



1. BOLT
2. ELBOW
3. GASKET
4. BOLT
5. GASKET
6. DISC
7. SIPHON BREAK HOUSING
8. BOLT
9. FUEL CHANNEL
10. FITTING
11. PLUG
12. SEAL
13. PLUG
14. FUEL INJECTION PUMP HOUSING COVER

Figure 7-6. Fuel Injection Pump Housing Cover, Disassembly and Assembly

1. BOLT
2. TORQUE SPRING COVER ASSY.
3. BOLT
4. SEAL
5. NUT
6. LOCKWASHER
7. WASHER
8. WASHER
9. SCREW ASSY
10. GASKET
11. COVER
12. BYPASS VALVE
13. CHECK VALVE
14. PIN
15. SEAL RING
16. SEAL RING
17. SLEEVE CONTROL SHAFT ASSY
18. SCREW
19. SLEEVE CONTROL LEVER
20. FUEL CONTROL SHAFT
21. LIFTER
22. ROLLER
23. FUEL INJECTION PUMP CAMSHAFT
24. PIN
25. STUD
26. DOWEL
27. SEAL RING
28. HOUSING ASSY
29. BEARING
30. BEARING
31. HOUSING

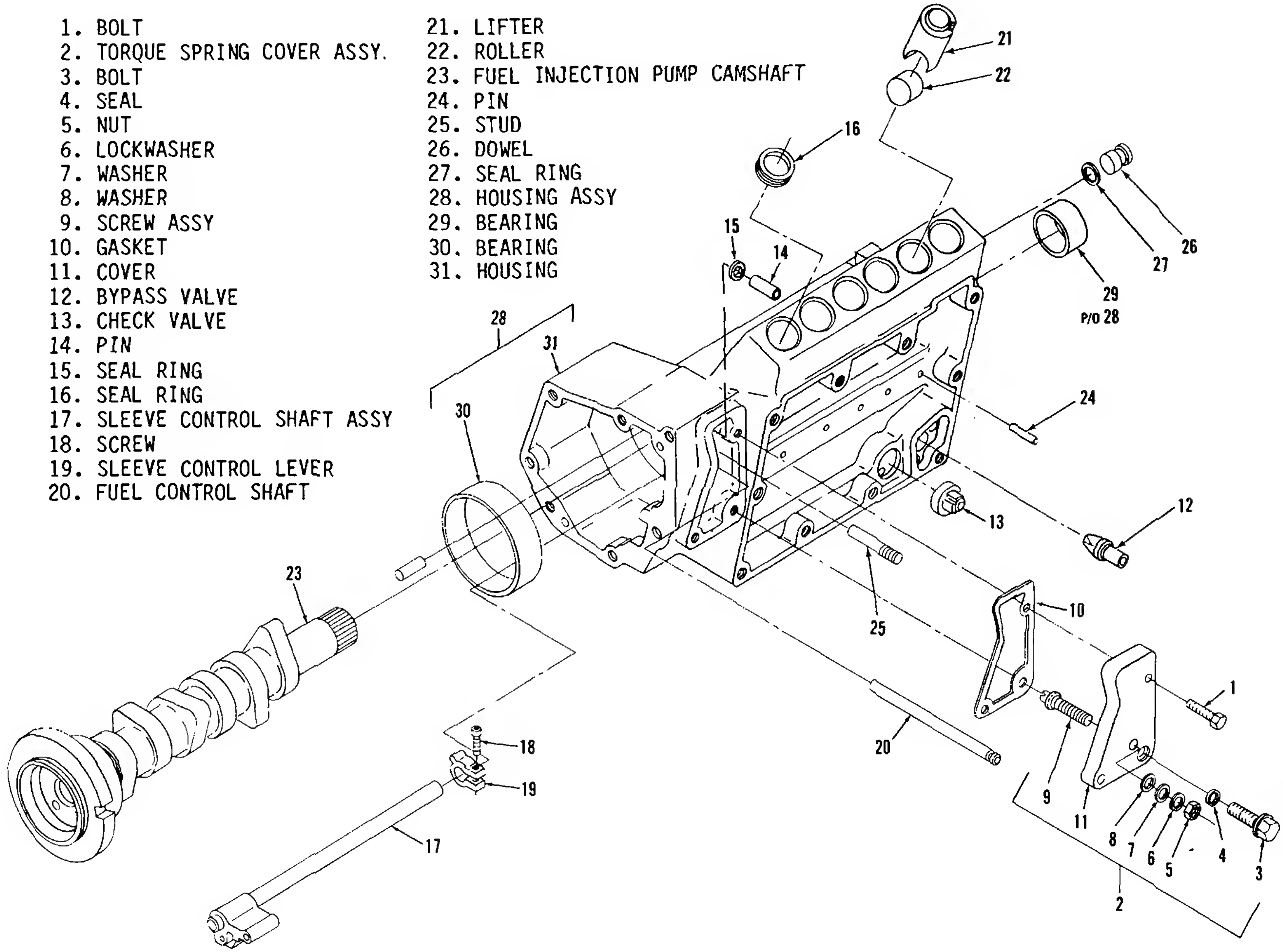


Figure 7-7. Fuel Injection Pump Housing, Disassembly and Assembly

7-11. ASSEMBLY OF FUEL INJECTION PUMP HOUSING.

a. Install bearings into housing (31).

b. Lubricate bore in housing assembly (28) and install seal (27) and dowel (26).

c. Install pins (24) and stud (25).

d. Slide fuel injection camshaft (23) into housing assembly (28).

CAUTION

Support camshaft (23) while installing rollers (22) and lifters (21) to prevent damage.

e. Install rollers (22) and lifters (21) into respective bores in housing assembly (28). Ensure that grooves in lifters align with pins (24) in housing assembly (28). Support camshaft (23) to prevent damage to pins (24) and bearings (29 and 30).

f. Put sleeve control shaft assembly (17) into housing assembly (28). Position levers (19) on shaft (17) and secure with screws (18). Push sleeve control shaft assembly (17) into position.

g. Install shaft (20). Torque screws (18) to 2 +/-0.16 foot-pounds (2.70 +/-0.22 Newton-meters).

h. Install seal rings (16 and 15) and pin (14).

i. Install check valve (13) and bypass valve (12).

j. Install screw assembly (9) into torque spring cover (11) and secure using washers (7 and 8), lockwasher (6), and nut (5).

k. Install seal (4) and bolt (3) into torque spring cover (11).

l. Install torque spring cover assembly (2) and gasket (10) using bolts (1).

m. Assemble cover assembly as follows (see figure 7-6):

(1) Install plug (13), seal (12), plug (11), and fitting (10) onto fuel injection pump housing cover (14).

(2) Install fuel channel (9) using bolts (8).

(3) Install gasket (5) onto siphon break housing (7). Attach housing (7) to cover (14) using bolts (4).

(4) Install disc (6), gasket (3), and elbow (2) using bolts (1).

n. Adjust sleeve control shaft assembly (17, figure 7-7) in accordance with paragraph 7-16.

o. Install fuel pump in accordance with paragraph 7-12.

p. Install fuel injection pumps in accordance with paragraph 7-13.

q. Install fuel injection pump housing in accordance with paragraph 7-14.

7-12. ASSEMBLY AND INSTALLATION OF FUEL PUMP.

a. Install shaft (8, figure 7-5) and dowel (7) into fuel pump body (10).

b. Install seal (6) into fuel pump body (10) using a driver. Ensure that lip of seal is toward pump gears (inward).

c. Install seal (5) into fuel pump body (10) using a driver. Ensure that lip of seal is away from pump gears (outward).

d. Install seal ring (4) and idler gear (3).

e. Install the key (12) and drive gear (11) onto the fuel injection pump camshaft.

f. Install the fuel pump body (10) onto housing and secure with bolts (2).

g. Position sleeve (1) onto fuel injection pump camshaft.

h. Use a 1/2-20 x 1.500 bolt (Special Tool S1603), washer (Special

Tool 48280) and washer (Special Tool 4N3371) arrangement to install sleeve (1) onto shaft (refer to table 2-1). Do not strike sleeve during installation. End clearance of camshaft must be 0.023 +/-0.018 inch (0.58 +/-0.46 mm) after sleeve is installed.

i. Install fuel injection pump housing in accordance with paragraph 7-14.

7-13. ASSEMBLY AND INSTALLATION OF FUEL INJECTION PUMPS.

NOTE

Ensure that sleeve (20, figure 7-4) is installed with the thin edge upward. Ensure that sleeve (20) and plunger (21) are installed in original barrel (22) and that large hole in plunger is up.

a. Install sleeve (20), plunger (21), spring (18), and washer (19) on the barrel (22).

b. Install check valve (15) and spring (16) into bonnet (17).

c. Connect barrel (22) and bonnet (17), and secure with ring (14).

d. Install bushing (12) onto assembled fuel injection pump (13).

e. Insert fuel injection pump (13) into bore of the fuel injection pump housing.

NOTE

When correctly installed, the sleeve (20) will be engaged with lever (19, figure 7-7). If the levers have been moved, a fuel pump adjustment must be made.

f. Secure fuel injection pump (13) by torquing bushing (12) to 70 +/-5 foot-pounds (95 +/-6.8 Newton-meters).

g. Install bypass valve spring (11). Ensure that spring (11) is correctly positioned, and install gasket (10) and cover (9).

h. Secure cover assembly (9) with bolts (7 and 8).

i. Install priming pump assembly (5) and gasket (6) using bolts (1 and 3) and washers (2 and 4).

7-14. INSTALLATION OF FUEL INJECTION PUMP HOUSING.

a. Set the number one cylinder to Top Dead Center (TDC) on compression stroke as follows:

(1) Refer to the Operator and Organizational Maintenance Manual, and remove the valve cover and starter motor.

(2) Turn the flywheel clockwise (opposite the direction of engine rotation) approximtely 30 degrees. This ensures that there will be no play in the timing gears when engine is set to TDC.

(3) Turn the flywheel counterclockwise until TC1 mark on flywheel aligns with timing pointer. If TC1 mark is turned beyond the timing pointer, turn the flywheel back (clockwise) a minimum of 30 degrees before turning counterclockwise towards alignment again.

(4) Observe the valves of number one cylinder. The valves will be closed if number one piston is at TDC compression position. When the number one cylinder is at TDC compression position, both rocker arms for the cylinder can be moved up and down freely.

(5) If the number one cylinder is not at top center compression position, turn the flywheel 360 degrees counterclockwise and bring the TC1 mark into alignment with the timing pointer again.

b. Install fuel injection pump drive gear (6, figure 7-3) onto fuel injection pump camshaft.

c. Install the fuel injection pump housing (7) onto the engine and secure with nuts (5).

d. Install bolt (1) and washer (2) which secure the drive gear (6). Torque to 110 +/-5 foot-pounds (149.2 +/-6.8 Newton-meters).

e. Recheck timing as follows:

(1) Remove timing pin (see figure 7-8).

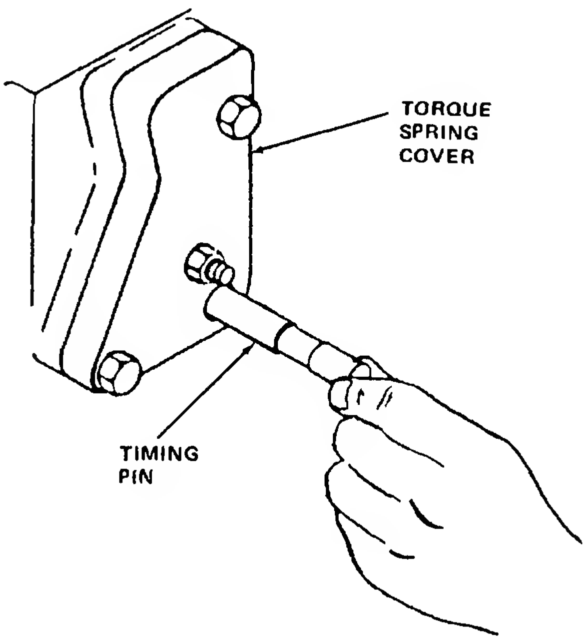


Figure 7-8. Use of Timing Pin

(2) Turn the crankshaft clockwise (as viewed from the front of the engine) approximately 1/2 turn.

(3) Insert timing pin and continue to turn crankshaft clockwise. Push gently on timing pin. The timing pin should slide into the groove in the fuel injection pump camshaft at the same point that the TC1 mark aligns with the timing pointer.

f. Install the drain line (4) and bleed line (3).

g. Refer to paragraph 11-44, step n, and install the fuel injection pump drive gear cover.

h. Refer to the Operator and Organizational Maintenance Manual and install the valve cover, fuel return line, fuel supply line, fuel injection lines, alternator belt, governor and governor drive adapter.

7-15. TESTING FUEL INJECTION PUMP CALIBRATION.

CAUTION

Ensure that both the outside of the fuel injection pump housing and the surrounding area is clean before starting this procedure.

NOTE

This procedure may be performed with the fuel injection pump housing either on or off the engine.

a. Refer to figure 7-6 and remove plug (11) and seal (12) from the fuel injection pump housing cover (14). Use a nonflammable container to hold any fuel which drains through this opening.

b. Refer to figure 7-4 and remove the fuel injection pump housing cover assembly (9), gasket (10), and bypass valve spring (11) in accordance with paragraph 7-8.

c. Refer to figure 7-7 and remove the torque spring cover assembly (2) in accordance with paragraph 7-10, step e.

d. Insert calibration pin (Special Tool 3P1545) with adapter (Special Tool 5P4226) into calibration hole (see figure 7-9, detail A). Secure adapter with bolts and washers provided with special tools.

e. Insert a setscrew (Special Tool 8S7271) into the adapter on top of the calibration pin. Torque setscrew to 1.7 to 2.1 foot-pounds (2.3 to 2.9 Newton-meters).

f. Refer to the Operator and Organizational Maintenance Manual, and

turn the governor control lever and shaft to full load position (fully counterclockwise). Secure the lever in this position.

g. Refer to paragraph 7-8 and remove the fuel injection pump to be checked.

NOTE

Ensure that calibration pump (Special Tool 3P1540) is supplied with spring (Special Tool 5P6557).

h. Clean the barrel and plunger of calibration pump (Special Tool 3P1540). Lubricate calibration pump with clean diesel fuel.

i. Insert the calibration pump in place of the fuel injection pump to be checked. Ensure that flat part of plunger faces the tang of the sleeve control lever (19, figure 7-7). When calibration pump is fully inserted with bore, rotate the pump 180 degrees so that the tang of the lever fits into the groove of the calibration pump (see figure 7-9, detail B).

j. Install bushing (12, figure 7-4) and torque to 70 +/-5 foot-pounds (95 +/-6.8 Newton-meters).

k. Put dial indicator (Special Tool 3P1568) with base (Special Tool 3P2226) on microgage and hold them together tightly (see figure 7-9, detail C). Loosen lockscrew and turn the face of dial indicator to put the pointer at "0". Tighten lockscrew.

l. Remove dial indicator from microgage. Look at the face of dial indicator and put dial indicator on microgage again. The pointer must move through one to one and one half revolutions before stopping at exactly "0". If the number of revolutions is not correct, loosen the locknut on the base (Special Tool 3P2226), and adjust the position of base until the pointer has the correct number of revolutions. Then do the check again. When the adjustment is correct proceed to step n.

m. Refer to figure 7-9, detail D, and put clamp (Special Tool 5P6562) in the position shown, next to the fuel pump end. The clamp pushes sleeve ontrol shaft assembly down against the bottom of its bearing. The other end of shaft is held down against its bearing calibration pin (Special Tool 3P1545) which is held by setscrew (Special Tool 8S7271). The combination of forces from clamp (Special Tool 5P6562) and the calibration pin is necessary to hold shaft in its normal operation position against the lifting force from spring in calibration pump.

n. Put dial indicator on the calibration pump as shown in figure 7-9, detail E. Hold it tightly in place. Move sleeve control shaft toward the governor end to remove end play. Push on sleeve control lever as shown (toward shutoff) several times. This removes any clearance in the linkage. Then look at the reading on the dial indicator.

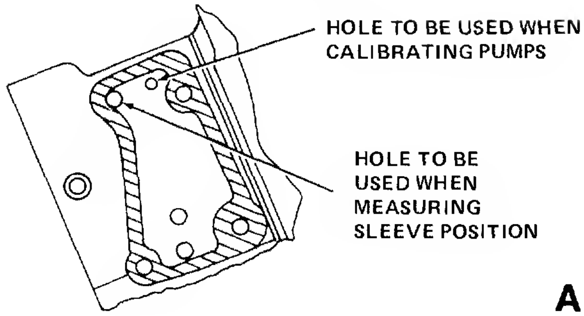
NOTE

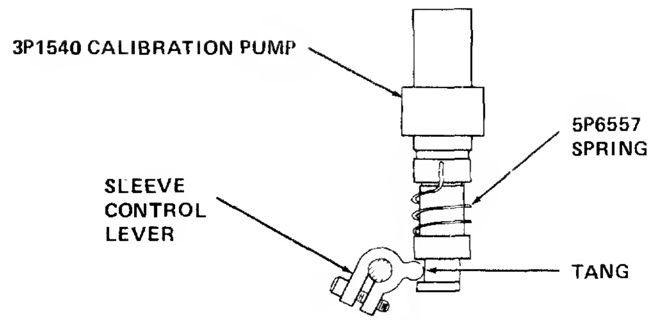
For troubleshooting purposes, if the dial indicator reading is "0" or near "0", the calibration of the other pumps is probably in the tolerance. For accuracy, all pumps must be tested.

o. If the dial indicator reading is greater than +/-0.0019 inch (+/-0.050 mm) from the 0.000 point (falls outside the total tolerance range shown on figure 7-9, detail F) the fuel injection pumps must be adjusted. If the reading is near either end of the total tolerance range, verify by testing another pump setting.

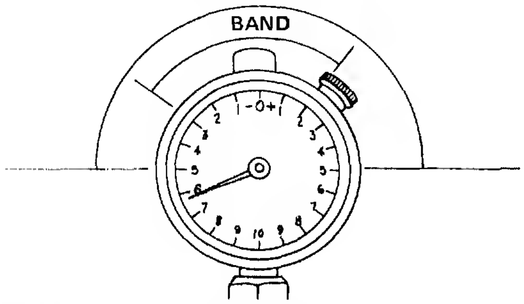
p. If the test readings for any two fuel injection pumps are different by 0.0019 inch (0.050 mm) or more, the fuel injection pumps must be adjusted.

q. If the fuel injection pumps are to be adjusted, proceed to paragraph 7-16. If the pumps are not going to be adjusted proceed to step r.





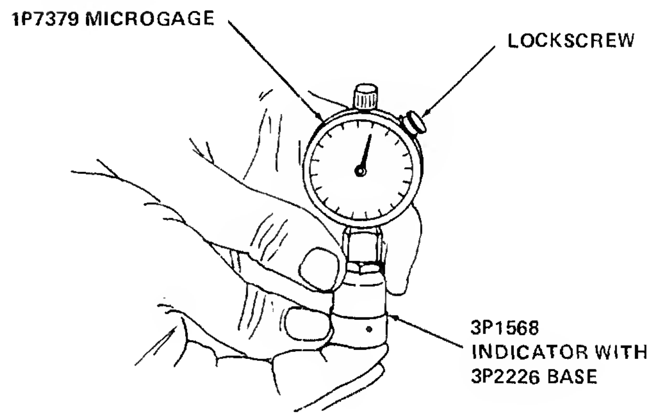
CALIBRATION PUMP INSTALLED **B**



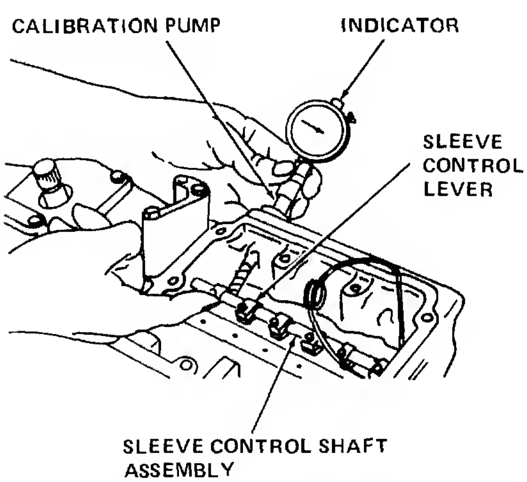
Desired reading for all pumps is "0.000".
Maximum permissible tolerance for all readings is ±0.002 inch (±0.050 mm).
Maximum permissible difference between any two pumps is 0.002 inch (0.050 mm).

TOTAL TOLERANCE shows the maximum permissible range of pointer positions which are acceptable. If the reading is outside the range of **TOTAL TOLERANCE, ADJUST** all pumps.

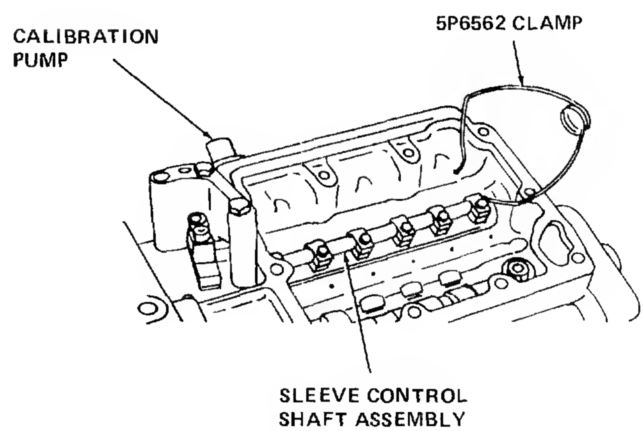
BAND is an example only. It shows a 0.002 inch (0.050 mm) range. This range shows the maximum permissible difference between any two readings for all the pumps. If any two readings are farther apart than the 0.002 inch (0.050 mm) range, do **ADJUST** all pumps. **F**



PUTTING DIAL INDICATOR ON ZERO **C**



DIAL INDICATOR POSITION **E**



5P6562 CLAMP INSTALLED **D**

Figure 7-9. Fuel Injection Pump Calibration Testing

r. Remove all calibration equipment.

s. Install the fuel injection pumps (13, figure 7-4) in accordance with paragraph 7-13. Torque bushings (12) to 70 +/-5 foot-pounds (95 +/-6.8 Newton-meters).

t. Free the governor control lever.

u. Refer to figure 7-7 and install the torque spring cover assembly (2) in accordance with paragraph 7-14.

v. Refer to figure 7-6 and install plug (11) and seal (12) onto fuel injection pump housing cover (14).

w. Refer to figure 7-4 and install the bypass valve spring (11), housing cover assembly (9), and gasket (10) in accordance with paragraph 7-14.

7-16. ADJUSTING FUEL INJECTION PUMP CALIBRATION.

a. Perform steps a through n, paragraph 7-15.

b. Remove all fuel injection pumps in accordance with paragraph 7-8.

NOTE

The calibration pump should already be installed in one of the fuel injection pump bores at this time.

c. Loosen screw (see figure 7-9, detail A) which holds the sleeve control lever to the sleeve control shaft assembly.

d. Turn the sleeve control lever enough to move the top of the calibration pump plunger to just below the top surface of the calibration pump (see figure 7-10, detail B). Tighten the screw just enough for the sleeve control lever to hold the plunger stationary. When the screw is correctly tightened, pushing with a small amount of force on the lever (using a wrench) moves the plunger upwards in the calibration pump.

e. Move the sleeve control shaft assembly towards the governor to remove end play.

f. Push down on sleeve control lever until top of plunger is almost even with top surface of the calibration pump.

g. Check dial indicator in accordance with paragraph 7-15, step 1.

h. Position dial indicator over the center of the calibration pump (see figure 7-10, detail B) and hold it there tightly.

NOTE

When moving plunger, ensure that the last movement is upwards. If plunger is raised too far, lower plunger and work upwards to desired position.

The action of tightening the screw usually changes the dial indicator reading by 0.0004 inch (0.010 mm).

i. Push sleeve control lever and move the calibration pump plunger until the dial indicator reads 0.000 inch (0.000 mm). Tighten screw to 2 +/-0.16 foot-pounds (2.7 +/-0.22 Newton-meters).

j. The dial indicator reading after tightening the screw must be 0.000 +/-0.0004 inch (0.000 +/-0.010 mm). Move sleeve control shaft toward shutoff several times to remove any clearance in the linkage. Recheck indicator reading.

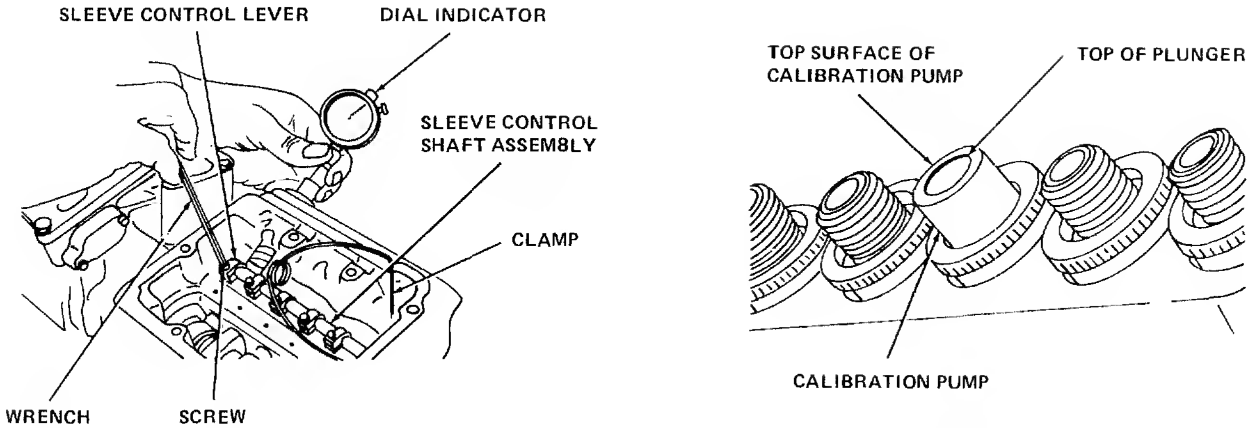
k. Record calibration and repeat for all other fuel injection pumps.

l. Remove all calibration equipment and proceed in accordance with paragraph 7-15, steps s through w.

7-17. REPAIR.

a. Repair minor thread damage using a suitable thread chaser.

b. Ream out clogged passages in fuel injection pump housing (28, figure 7-7) with thin, flexible wire. After cleaning, flush passages with fuel oil.



ADJUSTING FUEL PUMP CALIBRATION **A** PLUNGER POSITION **B**

Figure 7-10. Fuel Injection Pump Calibration Adjustment

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

c. Clean metal components with solvent, (P-D-680, Type II) to remove fuel oil, dirt, and accumulated deposits. Dry thoroughly.

7-18. OVERHAUL.

a. Refer to table 1-3 and, using a micrometer and feeler gage, check the following:

(1) Diameter of rear bearing surface (journal) of fuel injection pump camshaft (23, figure 7-7).

(2) Bore in bearing (30, figure 7-7).

(3) Camshaft rear bearing clearance.

(4) Diameter of sleeve control shaft (17, figure 7-7).

(5) Sleeve control shaft clearance.

(6) Bore in housing for fuel control shaft (20, figure 7-7).

(7) Diameter of front bearing surface (journal) of fuel injection pump camshaft (23, figure 7-7).

(8) Bore in bearing (29, figure 7-7).

(9) Camshaft front bearing clearance.

(10) Bypass valve spring (11, figure 7-4) length.

(11) Fuel injection pump spring (18, figure 7-4) length.

(12) Diameter of idler gear shaft in fuel pump (8, figure 7-5).

(13) Bore in idler gear (3, figure 7-5.

(14) Thickness of gears (3 and 11, figure 7-5).

(15) Clearance between end of gears and surface of pump body.

b. Replace any parts which do not meet the standards in table 1-3.

c Replace any parts which show signs of damage, distortion, or excessive wear.

d. Replace all springs, seals, and gaskets.

Section IV. MAINTENANCE OF FUEL INJECTION VALVES AND LINES

7-19. GENERAL. A fuel injection valve is located in each of the six precombustion chambers in the cylinder head. Fuel, under pressure from the injection pumps, is sent through the fuel lines (see figure 7-11) to the injection valves (3, figure 7-12). When pressurized fuel enters the nozzle assembly (6, figure 7-12), a check valve within the nozzle assembly opens to allow the fuel to pass. The nozzle changes the pressurized fuel into a spray of droplets as the fuel enters the precombustion chamber to provide the correct characteristics for good combustion.

7-20. TESTING FUEL INJECTION EQUIPMENT.

a. Perform general test of fuel injection equipment as follows:

NOTE

This test can isolate a cylinder which is misfiring or running rough, and causing black smoke in the exhaust. This test cannot determine if the fuel injection pump or injection valve is at fault.

(1) Operate the engine at whatever speed it is misfiring or running rough.

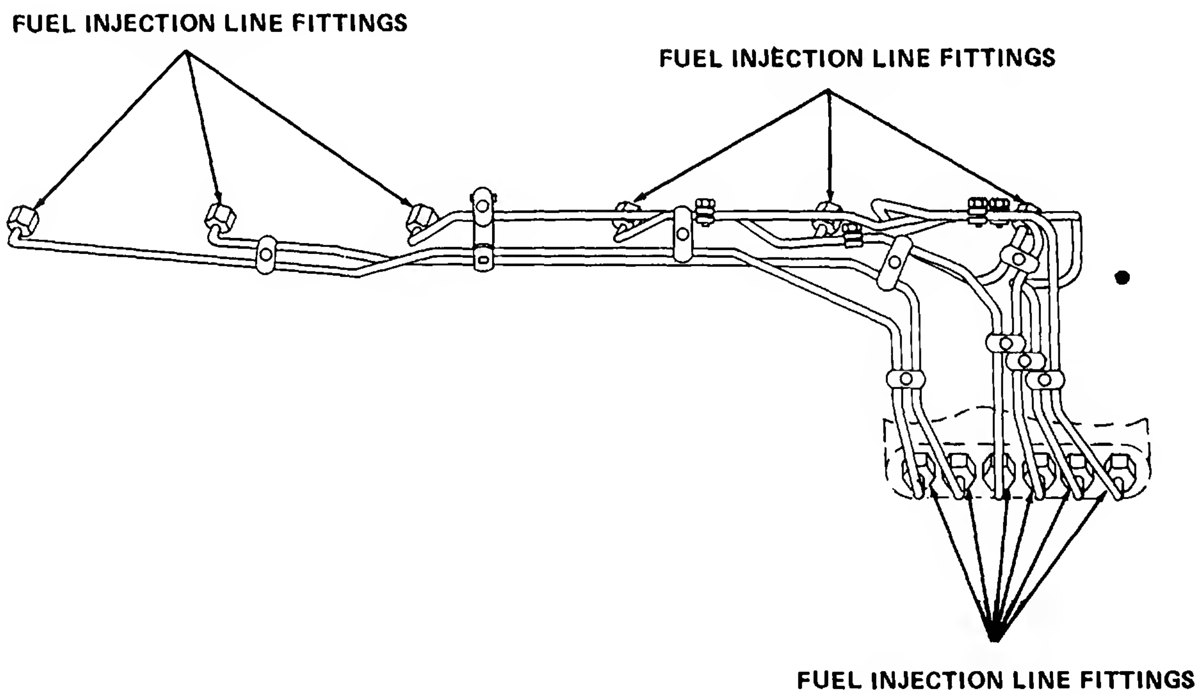
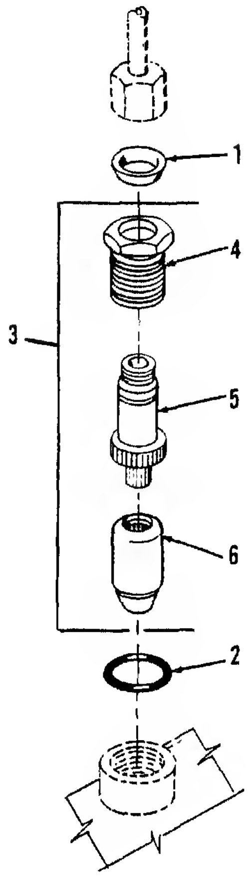


Figure 7-11. Fuel Injection Lines



1. SEAL
2. SEAL
3. FUEL INJECTION VALVE
4. NUT
5. BODY
6. NOZZLE ASSY

Figure 7-12. Fuel Injection Valve, Exploded View

(2) Loosen the fuel line fitting (see figure 7-11) to one injection valve at the fuel injection pump. This will stop the flow of fuel to that cylinder.

(3) Tighten the fitting to a torque value of 30 +/-5 foot pounds (40 +/-7 Newton-meters).

(4) Repeat test with each cylinder until a loosened fuel line fitting is found that makes no difference in engine misfiring. Begin test procedures with fuel injection valve and pump for that cylinder.

b. Refer to the Operator and Organizational Maintenance Manual, and tag and remove fuel injection valves.

c. Inspect fuel injection valves in accordance with the Operator and Organizational Maintenance Manual.

d. Using a diesel injector test stand and diesel injector tool set, test the fuel injection valves.

e. Refer to the Operator and Organizational Maintenance Manual to install fuel injection valves.

7-21. SERVICE.

a. Replace seals (1 and 2, figure 7-12).

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

b. Clean injection valves with solvent, (P-D-680, Type II) to remove fuel oil and accumulated desposits, and dry thoroughly.

7-22. REPAIR.

NOTE

Each fuel injection line is replaced as an assembly. The fittings cannot be replaced separately.

a. Repair minor thread damage to nut (84, figure 7-12) on body (5) using a thread chaser.

b. Repair damaged or defective nozzle assembly (6) by replacement. Do not open case or attempt repair.

c. Repair minor thread damage to fuel injection line fittings (see figure 7-10) using a thread chaser.

CHAPTER 8

MAINTENANCE OF COOLING SYSTEM

Section I. MAINTENANCE OF SHUTTER THERMOSTAT ASSEMBLY

8-1. GENERAL. The shutter thermostat assembly is mounted at the base of the radiator. It actuates the movable vanes in the shutter assembly. When engine coolant temperature reaches 158°F (70°C) the thermostat power element starts to extend and moves the control rod to open the shutter vanes. The vanes are fully open at 173°F (78.3°C). As coolant temperature decreases, the thermostat's integral return spring moves the control rod to close the shutter vanes. The modulated control automatically closes or opens the shutter vanes to maintain the engine at normal operating temperature. The shutter thermostat assembly is equipped with a manual control handle to permit manual opening of the shutter vanes.

8-2. REPAIR.

WARNING

Disconnect the negative cable of either battery.

a. Removal. Refer to Operator and Organizational Maintenance Manual and remove the shutter thermostat assembly

b. Disassembly. Refer to figure 8-1 and disassemble as follows:

(1) Remove cotter pin (1), rod (2), nut (4), lockwasher (5), and bolt (3) and remove lever (6).

(2) Remove retainer (12) and loosen setscrews holding yoke assembly (15) to shaft and slide shaft (14) out of yoke assembly (15). Remove yoke assembly. Remove and replace bushings (13 and 16) as required.

(3) Remove nut (9), friction spring (10), washer (8), and bolt (7) and remove manual control lever (11).

(4) Remove power element (17), preformed packing (19), and nut (18).

(5) Press in large seat (21) and remove retaining ring (23). Remove large seat slowly.

(6) Remove felt washer (22), large seat (21), spring (23), and small seat (24) from housing (25).

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

c. Cleaning. Clean parts with P-D-680, Type II, and dry thoroughly.

d. Inspection.

(1) Inspect threads for damage and parts for cracks.

(2) Inspect shaft for nicks, burrs, and scoring in flange bushing area.

(3) Inspect flange bushing for nicks, scores, and out-of-roundness.

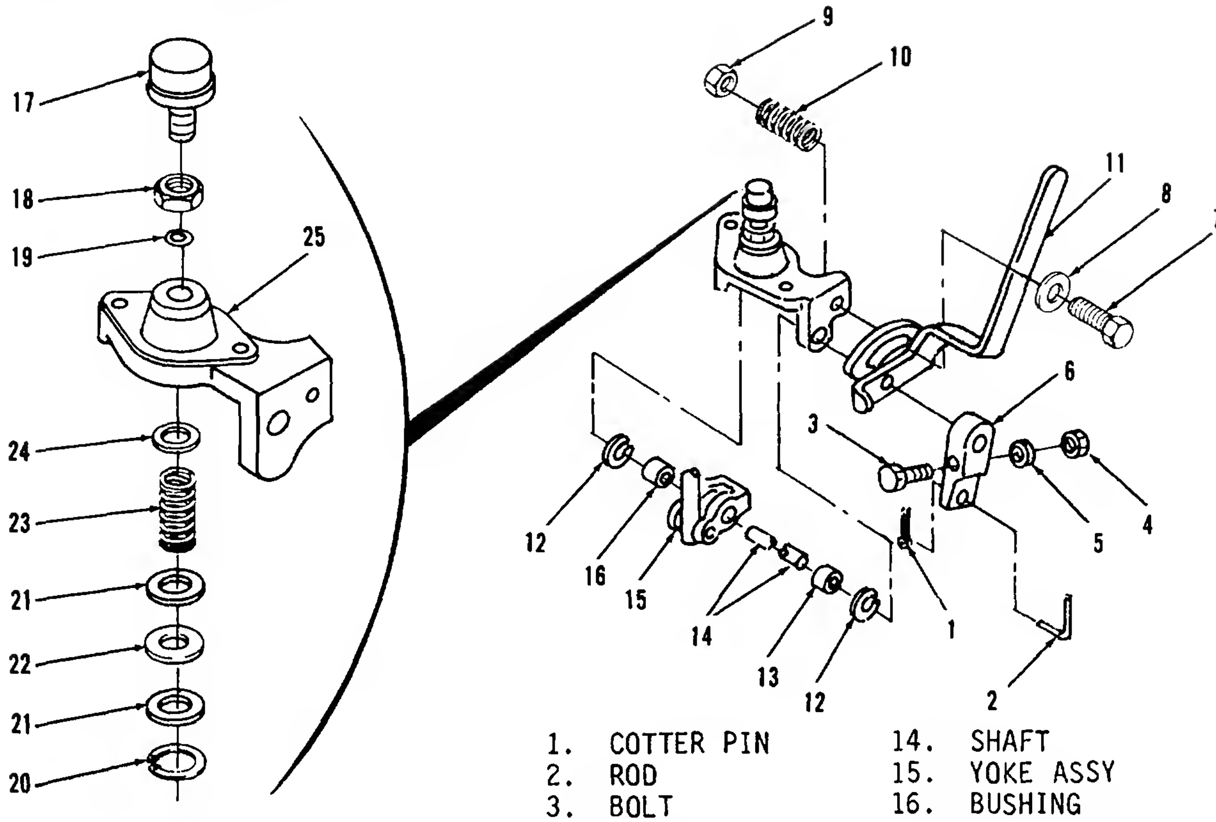
(4) Inspect springs for distortion and damage.

(5) Inspect manual control handle for distortion.

(6) Test power element. Refer to Operator and Organizational Maintenance Manual.

e. Repair.

(1) Remove nicks and burrs using a suitable file.



1. COTTER PIN
2. ROD
3. BOLT
4. NUT
5. LOCKWASHER
6. LEVER
7. BOLT
8. WASHER
9. NUT
10. SPRING
11. LEVER
12. RETAINER
13. BUSHING
14. SHAFT
15. YOKE ASSY
16. BUSHING
17. POWER ELEMENT
18. NUT
19. PREFORMED PACKING
20. RETAINER
21. LARGE SEAT
22. FELT WASHER
23. SPRING
24. SMALL SEAT
25. POWER ELEMENT HOUSING

Figure 8-1. Shutter Thermostat Assembly, Exploded View

(2) Straighten distorted manual control handle.

(3) Replace damaged or defective parts.

f. Assembly.

(1) Install small seat (24), spring (23), large seat (21), felt washer (22), large seat (21) and retainer ring (20) in housing (25).

(2) Apply a thin film of oil to preformed packing (19). Position nut (18) and preformed packing (19) on power element (17).

(3) Screw power element (17) into housing until top of element is 2.75 inches (68.85 mm) above flat of flange. Hold power element stationary and tighten nut (18).

(4) Position manual control lever (11) on shaft. Slide washer (8) onto bolt (7) and insert bolt through slot in handle and housing.

(5) Mount friction spring (10) on bolt (7) and secure with nut (9). Tighten nut enough to apply spring tension on manual control lever (11).

(6) Install yoke assembly (15) in housing (25). Slide shaft (14) through housing, yoke assembly, and bushings (13 and 16), and secure with retainers (12). Tighten setscrews on yoke assembly.

(7) Mount lever (6) on shaft (14) and secure with bolt (3), washer (5), and nut (4), cotter pin (1), and rod (2).

Section II. MAINTENANCE OF RADIATOR ASSEMBLY

8-3. GENERAL. The radiator assembly consists of top and bottom tanks, core assembly, vent tube, mounting brackets, upper and lower shrouds, and shroud plate. The shrouds and shroud plate are bolted to the radiator and ensure that air drawn by the fan is forced through the radiator when exiting the generator set. The upper tanks and mounting brackets are soldered to the core assembly. The brackets provide means for mounting the radiator. The tanks provide storage area for the coolant. Overflow coolant is vented through the vent tube.

8-4. TEST.

a. Removal. Refer to Operator and Organizational Maintenance Manual and remove the radiator.

b. Differential Pressure Test.

(1) Plug shutter power element port on the bottom radiator tank (refer to figure 8-2). Check that vent tube is free of obstructions by forcing compressed air through the tube. Install radiator cap.

NOTE

All test equipment must have a minimum of 2.5 ID inches (63.5 mm).

(2) Connect a water supply to lower radiator hose and reverse flush radiator until water flowing from upper radiator hose is clear.

(3) Disconnect water supply from lower hose and reconnect to upper hose. Flush radiator until water from lower hose is clear.

(4) Connect 0 to 20 (137.8 kPa) psi pressure gages to the upper and lower hose.

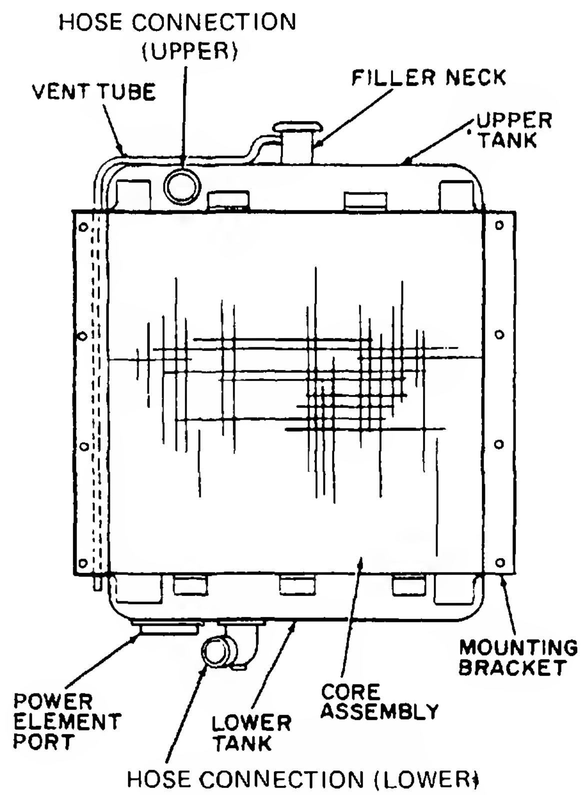


Figure 8-2. Radiator Assembly

(5) Connect a manual shutoff valve and an 80 gpm (303 liters per hour) water supply to the upper radiator hose.

(6) Connect the return line from the gage at the lower radiator hose to the water supply reservoir. Close manual shutoff valve.

CAUTION

Stop test immediately if pressure indicated at upper gage reaches 15 psi (103.35 kPa).

(7) Start water supply and slowly open manual shutoff valve while monitoring upper gage. Fully open shutoff valve and record pressure on both gages. If pressure differential exceeds 1. psi (12.4 kPa), the radiator is restricted.

(8) Shut down water supply, relieve pressure, and disconnect test equipment. If pressure differential exceeds 1.8 psi (12.4 kPa) remove radiator cap and perform the following:

CAUTION

Do not immerse cold radiator in boiling solution.

(a) Fill a boiling tank with a solution of 1 pound (0.45 kg) baking soda to each gallon (3.78 liters) of water and place radiator in tank.

(b) Bring solution to a boil and boil radiator for a minimum of 30 minutes.

(c) Remove radiator and repeat pressure differential test.

(d) If pressure differential still exceeds 1.8 psi (12.4 kPa), dismantle and clean radiator.

c. Pressure Test.

(1) Plug radiator filler neck, hose tubes, and shutter power element port.

(2) Connect a regulated air supply, manual shutoff valve, and 0 to 20 psi (137.8 kPa) pressure gage to the radiator vent tube.

(3) Place radiator in a suitable tank filled with water.

CAUTION

Do not exceed 15 psi (103.35 kPa) when applying pressure to radiator.

(4) Slowly apply 15 psi (103.35 kPa) to radiator and check for air bubbles that would indicate leaks. Mark leaks detected.

(5) Remove radiator from tank. Relieve air pressure and disconnect test equipment. Repair leaks.

8-5. REPAIR.

a. Disassembly. Refer to figure 8-2.

NOTE

Disassemble radiator only if required as a result of testing.

(1) Mark mounting brackets, top tank, and bottom tank in relation to core assembly to ensure proper reassembly.

(2) Remove oxide film on soldered joints.

(3) Unsolder vent tube, mounting brackets, top tank and bottom tank.

b. Cleaning.

(1) Remove excessive solder with a suitable torch and rag.

WARNING

Compressed air used for cleaning or drying can create airborne particles that may enter the eyes. Pressure shall not exceed 30 psig (206 kPa). Wearing of goggles is required.

(2) Use compressed air to remove obstructions from core fins.

(3) If core assembly tubes are clogged, boil core assembly in a solution of one pound baking soda to each gallon of water for a minimum of 30 minutes or until clog is loosened.

WARNING

Compressed air used for cleaning or drying can create airborne particles that may enter the eyes. Pressure shall not exceed 30 psig (206 kPa). Wearing of goggles is required.

(4) Use a cleaning rod or bristle brush to clean core assembly. Use compressed air to remove loosened particles.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

(5) Clean parts with P-D-680, Type II, and dry thoroughly.

c. Inspection.

(1) Test radiator cap using a cap tester. Cap setting should be approximately 7 psi (46.3 kPa). Check condition of locking taps.

(2) Inspect mounting brackets for cracks, distortion, and missing captive nuts. Inspect captive nuts for damaged threads.

(3) Inspect tanks for cracks, holes, or dents. Check hose connection and tubes for out-of-roundness, security and damage. Check filler neck for damage and security. Check bottom tank flange for security and damage to threads and gasket contact surface.

(4) Inspect core assembly for loose tubes, bent or damaged cooling fins and damage to tank contact surfaces.

(5) Inspect for damaged paint areas.

d. Repair.

WARNING

Welding operations produce heat, highly toxic fumes, injurious radiation, metal slag, and airborne particles. Welding goggles, the proper tinted lenses, apron or jacket, and welder's boots are required.

(1) Repair cracks in mounting brackets by welding. Straighten distorted parts.

(2) Replace defective mounting bracket captive nuts.

(3) Solder cracks and holes in tanks. Repair large holes or cracks. Resolder loose hose connection tubes, filler neck, or bottom tank flange. Remove burrs from flange with a file.

(4) Solder loose core assembly tubes. To repair damaged tubes, remove cooling fins in area of leak and solder leak. Solder cooling fins back into position. Replace defective tube by unsoldering and removing tube. Insert a replacement tube in core assembly and solder in position. Straighten bent cooling fins.

WARNING

Paint is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

(5) Scrape off damaged paint. Blend in edges, prime and paint damaged area using olive drab, per MIL-T-704, Type A, semi-gloss, No. X24807.

e. Reassembly.

(1) Use soldering equipment and fill core assembly tank contact surface grooves with solder.

(2) Align and solder upper and lower tanks to core assembly.

(3) Solder mounting brackets and vent tube into position.

(4) Conduct differential pressure and pressure tests after reassembly as described in step c above. Perform necessary repair procedures if radiator does not meet required test results.

f. Installation. Refer to Operator and Organizational Maintenance Manual and install radiator assembly.

Section III. MAINTENANCE OF WATER PUMP

8-6. GENERAL. The water pump is mounted on the front of the timing gear cover. The centrifugal-type pump is driven by the camshaft gear. The pump consists of an impeller and drive gear mounted on a common rotating shaft (see figure 8-3). Seals mounted on the shaft prevent water from leaking into the gear section and oil from leaking into the impeller section. As the engine is running, the gear turns the shaft and impeller. The impeller creates a forceful flow of water through the engine cooling system.

8-7. DISASSEMBLY.

a. Refer to the Operator and Organizational Maintenance Manual and remove the water pump.

b. Remove bolts (1 and 3, figure 8-3) and washers (2 and 4) to remove cover (5) and gasket (6).

c. Loosen bolt (7) 0.25 inch (6.35 mm). Strike the bolt with a soft hammer to loosen impeller (9) from shaft (20).

d. Remove bolt (7), washer (8), impeller (9), and seal assembly (10).

e. Remove ring (11) and seal (12).

f. Remove bolt (13) and washer (14).

g. Remove gear and bearing assembly (15). Remove bearing (16) from gear assembly (17) using driver.

h. Remove ring (18).

i. Remove bearing (19) and shaft (20).

j. Remove seals (21 and 22).

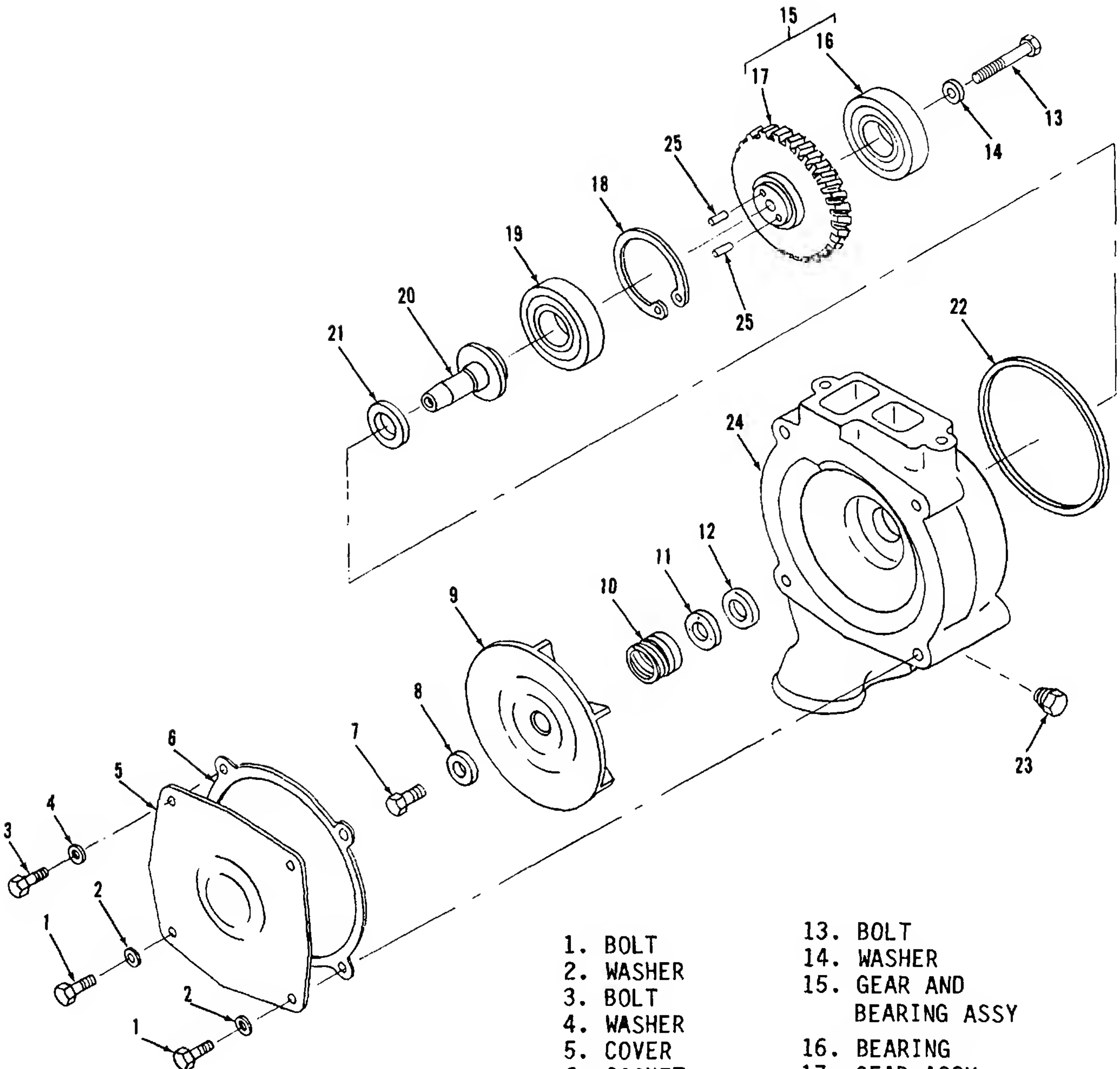
k. Remove plug (23) from housing (24).

8-8. REPAIR.

a. Repair minor thread damage using a thread chaser.

b. Remove minor nicks and burrs using a file or hone.

c. Replace, do not repair, damaged or defective impeller (9), bearings (16 and 21), gear assembly (17) and shaft (20).



1. BOLT
2. WASHER
3. BOLT
4. WASHER
5. COVER
6. GASKET
7. BOLT
8. WASHER
9. IMPELLER
10. SEAL ASSY
11. RING
12. SEAL
13. BOLT
14. WASHER
15. GEAR AND BEARING ASSY
16. BEARING
17. GEAR ASSY
18. RING
19. BEARING
20. SHAFT
21. SEAL
22. SEAL
23. PLUG
24. HOUSING

Figure 8-3. Water Pump, Exploded View

d. Discard and replace all seals and gaskets.

8-9. ASSEMBLY.

a. Install plug (23) into housing (24).

b. Install seal (22).

NOTE

Seal (21) must be placed with spring facing oil side of pump.

c. Install seal (21).

d. Install shaft (20) and bearing (19). Install ring (18) to secure bearing (19).

e. Install bearing (16) on gear assembly (17). Install gear and bearing assembly (15) into housing (24) and secure with bolt (13) and washer (14).

f. Install seal (12) and ring (11).

g. Install seal assembly (10) into housing (24).

h. Install impeller (9), washer (8), and bolt (7). Torque bolt (7) to 28 +/-1 foot-pounds (36.6 +/-4 Newton-meters).

i. Install gasket (6) and cover (5) using bolts (1 and 3) and washers (2 and 4).

j. Install water pump in accordance with the Operator and Organizational Maintenance Manual.

Section IV. FAN GUARD

8-10. GENERAL. The fan guards are mounted on the radiator shroud plate and prevent personnel from coming into contact with the fan.

8-11. REPAIR.

a. Removal. Refer to Operator and Organizational Maintenance Manual and remove fan guards.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

b. Cleaning. Clean fan guards with cleaning solvent, P-D-680, Type II, and dry guards thoroughly.

c. Inspection. Inspect fan guards for bent or broken crossmembers.

d. Repair. Straighten bent parts of fan guard.

e. Installation. Refer to Operator and Organizational Maintenance Manual and install fan guard.

CHAPTER 9

MAINTENANCE OF LIFTING AND SUPPORT SYSTEM

9-1. GENERAL. The lifting frame is bolted to the skid base and provides the means of lifting the generator set. Two clevis bolts are located at the top of the lifting frame to permit attachment of a suitable lifting device. The lifting frame comprises the center support for the housing. The support system reinforces the sides of the rear housing panel, which includes the control panel and air intake louvers.

9-2. REPAIR. Repair damaged frame or control panel housing supports as follows:

a. If required, remove damaged lifting frame or housing supports in accordance with the Operator and Organizational Maintenance Manual.

WARNING

Welding operations produce heat, highly toxic fumes, injurious radiation, metal slag, and airborne particles. Welding goggles, the proper tinted lenses, apron or jacket, and welder's boots are required.

b. Repair cracks by welding.

WARNING

Paint is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

c. Remove paint. Blend in edges, prime, and repaint damaged areas using olive drab, per MIL-T-704, Type A, semi-gloss, No. X24807.

d. Install lifting frame or housing supports in accordance with the Operator and Organizational Maintenance Manual.

CHAPTER 10

MAINTENANCE OF POWER GENERATION SYSTEM

10-1. GENERAL. The generator is a brushless type with a rotating exciter. The armature of the exciter, the field of the generator, and the rectifier assembly are mounted on the same rotating shaft. The field of the exciter and armature of the generator are stationary. The output of the generator armature is kept constant by the exciter-regulator. In order to build up the voltage of a generator, the residual magnetism of its pole pieces is generally relied upon to produce a small initial voltage which increases as the generator comes up to speed. If this is not sufficient, the field flash circuit applies a short burst of 24 V dc to the exciter field. The voltage induced into the exciter armature is fed from the exciter armature to the bridge rectifier assembly, the dc output of which is coupled to the generator field rotating on the common shaft. The generator field induces an ac voltage (the output) in the stationary armature windings.

10-2. ON-EQUIPMENT TEST. A malfunction of the generator is usually indicated by either low output voltage or no voltage output. To isolate the malfunction proceed as follows:

a. Disconnect generator set air intake doors (mounted below control cubicle) by removing fourteen screws, washers, and nuts.

b. Disconnect generator set air inlet louver and screen assembly, by removing twenty screws, washers, and sixteen nuts.

WARNING

HIGH VOLTAGE

is produced when the generator set is in operation.

c. Remove electrical connector P61 from right side of generator endbell.

d. Connect a variable dc voltage supply (0 to 10 volt, 15 amperes) in series with a 0 to 10 dc ammeter to connector J61 pin C (positive) and pin B (negative). Set variable voltage supply to zero.

e. Start generator set and operate engine at 1800 rpm.

f. Adjust variable voltage supply until normal generator output voltage is obtained (120/208 or 240/416). Test dc ammeter should indicate 3 to 3.5 amperes.

g. Remove external power supply and shut down generator set.

h. If above requirements are met, refer to paragraph 6-16 and 6-17 and test the regulator. If requirements are not met, proceed as indicated below.

NOTE

Generator temperature should be approximately 77°F (24.2°C) during resistance test.

i. Check resistance between connector J61 pins B and C using a Wheatstone Bridge or other suitable low-resistance measuring device. Resistance should be 1.23 ohms +/-10 percent.

j. Check insulation resistance of exciter stator by electrically bonding connector J61 pins B and C together. Connect lead from pins to a 500 volt megger and connect other megger lead to frame. Resistance reading should be a minimum of 50K ohms.

NOTE

Interconnecting wiring information is contained in Operator and Organizational Maintenance Manual.

k. Remove plastic shield from reconnection panel. Remove voltage change board. Disconnect electrical connector P10 from Mode I relay box connector J10, and electrical connector P13 from exciter regulator connector J13. Check resistance between generator leads T1-T4, T2-T5, T3-T6, T7-T10, T8-T11, and T9-T12, using a Kelvin Bridge or other suitable low-resistance measuring device. Resistance should be 0.00974 ohm +/-10 percent.

l. Check insulation resistance of main stator by connecting all twelve leads (T1 through T12) together. Connect one of the twelve generator leads to a 500-volt megger: connect other megger lead to frame. Resistance reading should be a minimum of 50K ohms. Connect electrical connector P10 to J10 on Mode I relay box and electrical connector P13 to J13 on exciter regulator. Install voltage change board and plastic shield over the reconnection board.

NOTE

Figure 1-4 is the generator assembly simplified schematic.

m. Disconnect endbell and exciter stator assembly (61, figure 10-1) from generator by removing screws (59) and lockwashers (60). Tag and disconnect six diode leads from rectifier assembly (12) and test each diode for an open or short.

n. Tag and disconnect two main rotor leads from rectifier assembly. Check resistance between two rotor leads using a Kelvin Bridge or other suitable low-resistance measuring device. Resistance should be 0.834 ohm +/-10 percent.

o. Check insulation resistance of main rotor by connecting the two leads together. Connect two leads to a 500-volt megger: connect other megger lead to rotor shaft. Resistance reading should be a minimum of 50K ohms.

p. Tag and disconnect three exciter rotor leads from rectifier assembly. Check resistance between exciter rotor leads R1-R2 and R2-R3, using a Kelvin Bridge or other suitable low-resistance measuring device. Resistance should be 0.0773 ohm +/-10 percent.

q. Check insulation resistance of exciter rotor by connecting the three leads together. Connect three leads to a 500-volt megger: connect other megger lead to rotor shaft. Resistance reading should be a minimum of 50K ohms.

r. Connect main stator, exciter rotor, and diode leads to rectifier assembly. Install endbell and exciter stator assembly (61). Connect electrical connector P61 to electrical connector J61 on generator endbell. Install air inlet louver and screen assembly and secure with screws, washers, and nuts. Install generator set air intake doors and secure with screws, washers, and nuts.

10-3. REMOVAL AND REPLACEMENT. Remove the generator as specified in Chapter 2.

10-4. DISASSEMBLY. Refer to figure 10-1 and disassemble generator as follows:

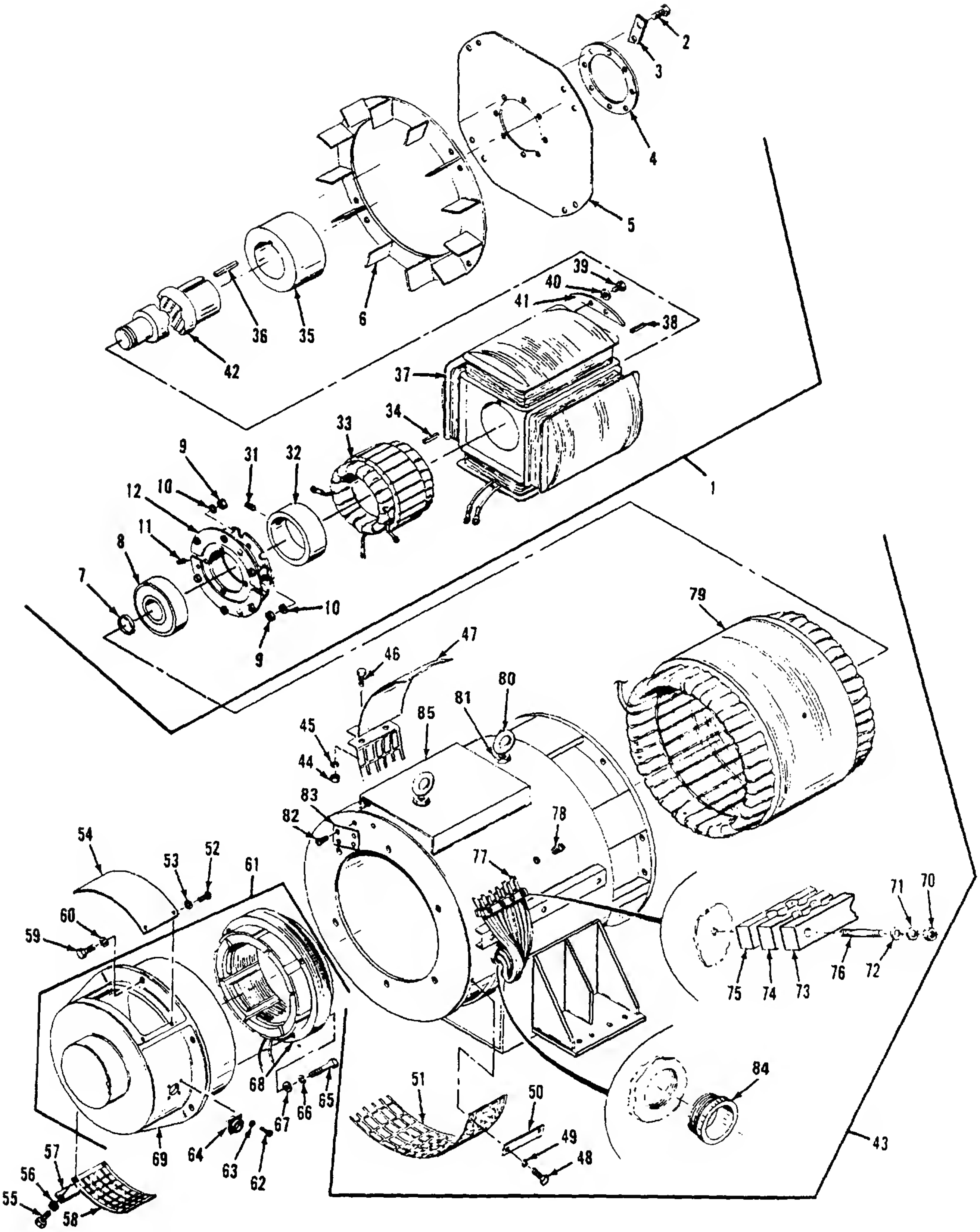
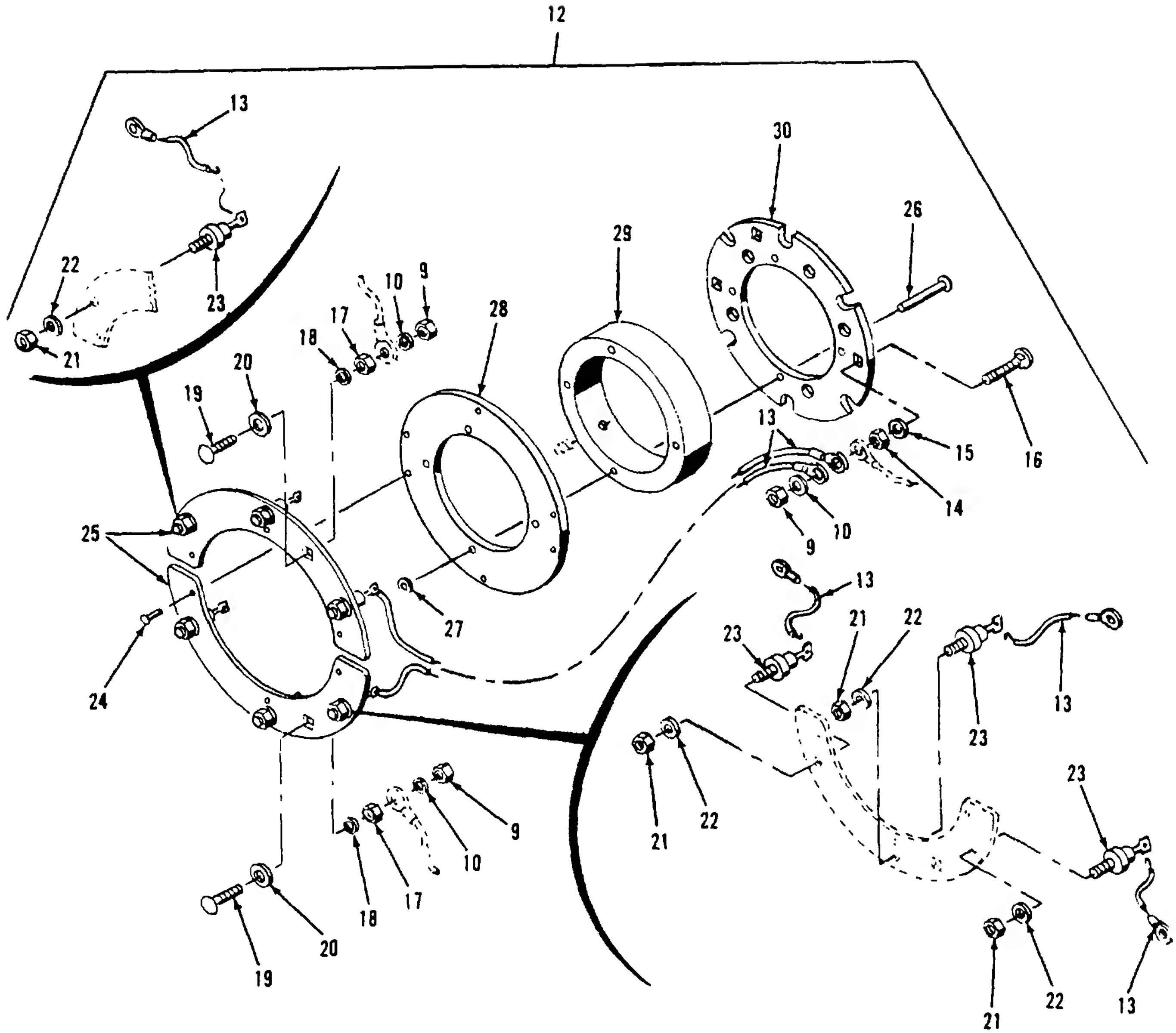


Figure 10-1. Generator Assembly G1, Exploded View (Sheet 1 of 2)



1. MAIN ROTOR AND SHAFT ASSY
2. SCREW
3. CLIP LOCKS
4. RETAINER
5. SHAFT COUPLING
6. FAN
7. SNAP RING
8. BEARING
9. NUT
10. LOCKWASHER
11. SETSCREW
12. RECTIFIER ASSY
13. DIODE LEAD
14. NUT
15. LOCKWASHER
16. BOLT
17. NUT
18. LOCKWASHER
19. SCREW
20. WASHER
21. NUT
22. LOCKWASHER
23. DIODE
24. RIVET
25. HEAT SINK
26. RIVET
27. WASHER
28. PLATE
29. HUB
30. INSULATOR
31. SETSCREW
32. SPACER
33. EXCITER ROTOR ASSY
34. KEY
35. HUB
36. KEY
37. MAIN ROTOR SUBASSY
38. KEY
39. SCREW (AS REQUIRED)
40. LOCKWASHER (AS REQUIRED)
41. BALANCE WEIGHT (AS REQUIRED)
42. SHAFT

Figure 10-1. Generator Assembly G1, Exploded View (Sheet 2 of 2)

LEGEND FOR FIGURE 10-1 (Continued)

43. MAIN STATOR AND FRAME ASSY
44. NUT
45. LOCKWASHER
46. SCREW
47. SCREEN
48. SCREW
49. LOCKWASHER
50. CLIP
51. SCREEN
52. SCREW
53. LOCKWASHER
54. COVER
55. SCREW
56. LOCKWASHER
57. CLIP
58. SCREEN
59. SCREW
60. LOCKWASHER
61. ENDBELL AND EXCITER STATOR ASSY
62. SCREW
63. LOCKWASHER
64. CONNECTOR
65. SCREW
66. LOCKWASHER
67. WASHER
68. EXCITER STATOR ASSY
69. ENDBELL
70. NUT
71. LOCKWASHER
72. WASHER
73. CLAMP
74. CLAMP
75. CLAMP
76. STUD
77. LEADS
78. SETSCREW
79. MAIN STATOR ASSY
80. LIFTING EYBOLT
81. NUT
82. SCREW
83. NAMEPLATE
84. INSULATION BUSHING
85. MAIN STATOR FRAME

a. Ensure that shipping block (refer to table 2-3) is installed on main stator and frame assembly (43) and fan (6) is secure to shaft couplings (5).

WARNING

Ensure that generator is properly blocked to prevent injury to personnel during disassembly.

b. Attach a cable hook and lifting device (capable of lifting 3-ton (2.7 t) minimum) to generator lifting eyebolt (80). Position generator in a vertical position: rest generator endbell and exciter stator assembly (61) on wooden blocks. Position 12 inch by 12 inch (305 by 305 mm) wooden blocks (two each side) under generator mounting brackets on main stator frame assembly (85) to prevent generator from tipping over. Remove lifting device.

c. Remove shipping block. Bend down corners of clip locks (3), and using a bar tool, hold shaft couplings (5) while removing two screws (2) located 180 degrees apart. Install lifting fixture (refer to table 2-3) and secure with two 0.500-20 x 3.00 screws to main rotor and shaft assembly (1). Install lifting eyebolt (80) in lifting fixture. Using a cable hook and lifting device, lift main rotor and shaft assembly (1) from main stator and frame assembly (43).

d. Place main rotor and shaft assembly (1) on a bench: rest the main rotor subassembly (37) on cushion material to prevent damage. Allow fan (6) and shaft coupling (5) to hang over side of bench.

e. Remove lifting eyes from main rotor and shaft assembly (1).

f. Remove remaining screws (2), clip locks (3), retainer (4), shaft couplings (5), and fan (6). Disconnect fan (6) from shaft couplings (5) by removing shipping screws and nuts.

NOTE

Do not remove bearing (8) unless proven defective at time of inspection or further disassembly is required.

g. Remove snap ring (7) and using a puller, remove bearing (8) from shaft (42).

h. Tag and disconnect electrical leads from rectifier assembly (12) by removing nuts (9) and lockwashers (10). Remove setscrew (11) and remove rectifier assembly (12) from shaft (42).

NOTE

Do not disassemble rectifier assembly unless proven defective at time of inspection.

i. Disassembly of rectifier assembly (12) is as follows:

(1) Disconnect diode leads (13).

(2) Remove diodes (23) from heat sinks (25).

(3) Unsolder leads (13) from diodes (23).

(4) Remove heat sinks (25) from plate (28) by removing rivet (24).

(5) Separate insulator (30), hub (29), and plate (28).

j. Remove setscrew (31) and using a puller, remove spacer (32), exciter rotor assembly (33), and key (34) from shaft (42).

NOTE

Do not remove main rotor subassembly (37) from shaft (42) unless found defective at inspection.

k. Using a puller, remove hub (35) and key (36) from shaft (42).

l. Using an arbor, press shaft (42) from main rotor subassembly (37) and remove key (38). Do not remove screws (39), washers (40), and balance weights (41) from main rotor subassembly (37).

m. Turn main stator and frame assembly (43) over and position frame assembly on wooden blocks with endbell on top. Block assembly to prevent tipping.

n. Remove screens (47, 51, and 58) and cover (54) as follows:

(1) Remove nuts (44), washers (45), screws (46), and screen (47).

(2) Remove screws (48), washers (49), clip (50), and screen (51).

(3) Remove screws (55), lockwashers (56), clip (57), and screen (58).

(4) Remove screws (52), lockwashers (53), and cover (54).

o. Remove screws (59) and washers (60), then remove endbell and exciter stator assembly (61).

p. Remove screws (62) and washers (63), then lift connector (64) from side of endbell (69), tag and unsolder exciter stator (68) leads from connector (64). Remove screws (65), lockwashers (66), and washers (67), then remove exciter stator assembly (68) from endbell assembly.

NOTE

Remove main stator assembly (79) only if defective.

q. Remove nuts (70), lockwashers (71), washers (72), and clamps (73, 74, and 75).

WARNING

An acetylene torch is capable of producing heat, highly toxic fumes, injurious radiation, metal slag, and airborne particles. Although the torch is not being used for welding, welding goggles, the proper tinted lenses, apron or jacket, and welder's boots are required.

r. Remove two setscrews (78) and remove main stator assembly (79) from main stator frame (85) by evenly heating the frame with an acetylene torch.

10-5. CLEANING.

WARNING

Compressed air used for cleaning or drying can create airborne particles that may enter the eyes. Pressure shall not exceed 30 psig (206 kPa). Wearing of goggles is required.

a. Use a clean cloth and low-pressure, 10 to 15 psi (68.9 to 103.4 kPa) compressed air, and remove dust and dirt from windings and frame.

WARNING

Cleaning solvent trichloroethane (Tri-ethane) 1.1.1 (MIL-T-81533A) is flammable and toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory tract protection is required.

See OS.1 del

~~b. Use a clean lint-free cloth moistened with cleaning solvent (tri-ethane 1.1.1) (MIL-T-81533A), to remove heavy deposits from windings and dry thoroughly and to clean the rectifier assembly and all metal parts.~~

10-6. INSPECTION.

a. Inspect generator frames for cracks and burred mating surfaces.

b. Inspect generator frames for cracked welds and distortion.

c. Inspect shaft couplings for distortion and elongated holes.

d. Inspect shaft for nicks and scratches.

e. Inspect fan for distortion, elongated holes, or chipped blades.

f. Inspect screens for distortion and bent corners.

g. Inspect nuts, bolts, and screws for damaged threads and heads.

h. Rotate bearing and check for freedom of movement, flat spots, binding, and signs of overheating. Measure bearing inside diameter. Diameter should be:

2.7551 to 2.7559 inches (69.9795 to 69.9998 mm)

Check bearing outside diameter. Diameter should be:

5.89997 to 5.90005 inches (149.8592 to 149.8612 mm)

i. Measure shaft bearing contact surface; shaft should be 2.7565 to 2.7560 inches (70.0157 to 70.0024 mm).

j. Measure endbell bearing contact; endbell should be 5.9062 to 5.9055 inches (150.0174 to 149.9997 mm).

NOTE

Generator windings temperature should be approximately 77°F (24.75°C) during resistance checks. Resistance checks should be made using a Kelvin Bridge (or equivalent) for resistance values below 1 ohm. Resistance values of windings are to be within a tolerance of +10 percent.

k. Check main stator resistance between leads: T1-T4, T2-T5, T3-T6, T7-T10, T8-T11, and T9-T12. Resistance should be 0.00974 ohm.

l. Check main rotor resistance between leads R4 and R5. Resistance should be 0.834 ohm.

m. Check exciter rotor resistance between leads R1-R2 and R2-R3. Resistance should be 0.0772 ohm.

n. Check exciter stator resistance between leads F1 and F2. Resistance should be 1.23 ohms.

NOTE

Generator windings insulation resistance checks should be made using a 500-volt megger. Resistance readings should be a minimum of 50K ohms.

o. Check insulation resistance of main stator windings by connecting all twelve leads together and then, connecting a megger between leads and stator frame.

p. Check insulation resistance of main rotor winding by connecting rotor leads together and then, connecting a megger between rotor leads and rotor frame or shaft.

q. Check insulation resistance of exciter rotor winding by connecting the three rotor leads together and then, connecting a megger between leads and rotor frame or rotor shaft.

r. Check insulation resistance of exciter stator winding by connecting stator leads together and then, connecting a megger between leads and rotor frame.

s. Inspect rectifier assembly as follows:

(1) Disconnect diodes from the rectifier assembly and test each diode separately using a multimeter.

(2) Connect the multimeter across the diode; meter positive lead on the anode (back end of arrow) and negative meter lead on the cathode (tip of the arrow). A low resistance should be indicated.

(3) Reverse multimeter leads; a high resistance (at least 100 times low reading) should be indicated.

t. Inspect paint for damage.

10-7. REPAIR, OVERHAUL, AND REBUILD.

WARNING

Welding operations produce heat, highly toxic fumes, injurious radiation, metal slag, and airborne particles. Welding goggles, the proper tinted lenses, apron or jacket, and welder's boolts are required.

a. Repair cracks by welding as long as it does not distort or impair strength of part.

b. Remove burrs or nicks using a suitable file or stone.

c. Straighten dented or distorted sheet metal parts using suitable tools.

d. Overhaul or rebuild main stator assembly as specified in figure 10-2.

e. Overhaul or rebuild main rotor assembly as specified in figure 10-3.

f. Overhaul or rebuild exciter rotor assembly as specified in figure 10-4.

g. Overhaul or rebuild exciter stator assembly as specified in figure 10-5.

WARNING

Paint is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

h. Remove damaged paint with a suitable scraper. Blend in edges, prime, and paint damaged areas using olive drab, per MIL-T-704, Type A, semi-gloss, No. X24807.

10-8. REASSEMBLY. Refer to figure 10-1 and reassemble generator as follows:

NOTE

Figure 1-4 is the generator assembly simplified schematic diagram.

a. Heat main stator frame (85) in an oven to 200°F (97.9°C) for ease of installing main stator assembly (80).

b. Place heated main stator frame assembly (85) in a vertical position, resting exciter end on wooden blocks.

CAUTION

Exercise care when installing main stator assembly (79) into main stator frame (85) to prevent damage to windings.

c. Position main stator assembly (79) so that setscrew (78) holes are aligned with holes in main stator frame (85). Start leads (77) through insulation bushing (84). Pull leads and slide main stator assembly (79) into main stator frame (85) until setscrew (78) holes are aligned.

d. Install setscrew (78): tighten to 5 foot-pounds (6.9 Newton-meters) torque.

e. Cut output leads (77) to lengths specified in table 10-1. Strip insulation back 0.62 inches (157.5 mm) and install terminal lugs on leads (77).

f. Position clamp (75) on generator and install generator output leads in the following sequence starting at exciter end: T12, T11, T10, T9, T8, and T7. Install clamp (74) and install the following output leads starting at exciter end: T6, T5, T4, T3, T2, and T1. Install clamp (73) and tighten washers (72), lockwashers (71), and nuts (70) finger tight.

Form an appropriate 5 inch (127 mm) loop in output leads between insulation bushing (84) and clamps. Make sure leads are in proper position and tighten nuts (70).

g. Insert exciter stator assembly (68) leads in connector (64) opening. Install exciter stator assembly into endbell (69), pulling leads through opening as exciter stator is installed. Cut exciter stator assembly leads to permit connection to connector (64), when connector is approximately 1 inch (25.4 mm) from endbell (69). Secure exciter stator assembly with screws (65), lockwashers (66), and washers (67). Strip lead insulation back approximately 0.375 inch (3.525 mm) and solder lead F1 to connector pin C and lead F2 to connector pin B. Install connector (64) with key on top using screws (62) and washers (63).

h. Install endbell and exciter stator assembly (61) on main stator and frame assembly (43) with connector (64) positioned at 3 o'clock looking from rear of generator. Secure with screws (59) and washers (60).

i. Install cover (54) and screens (47, 51, and 58) as follows:

(1) Install cover (54) using screws (52) and lockwashers (53).

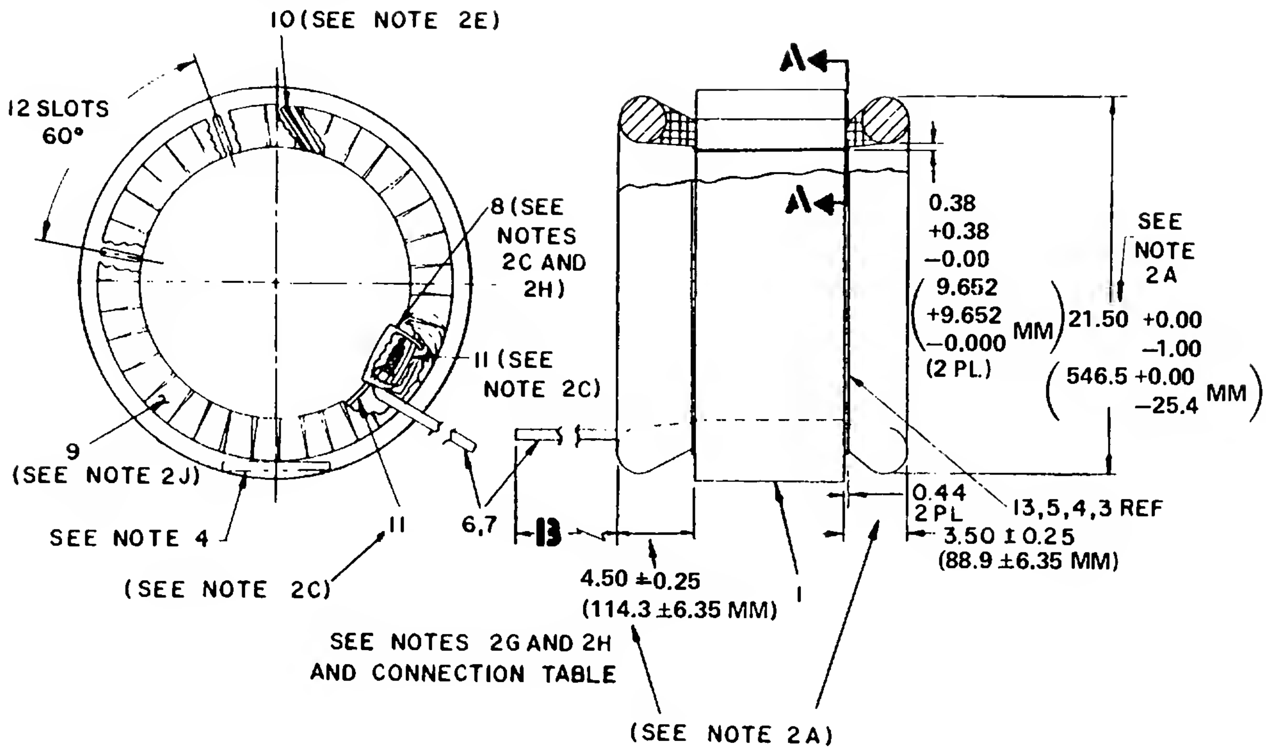
(2) Install screen (58) using screws (55), lockwashers (56), and clip (57).

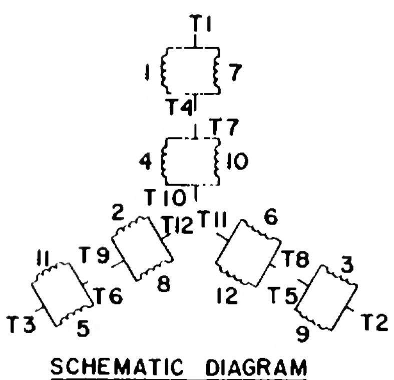
(3) Install screen (51) using screws (48), washers (49), and clip (50).

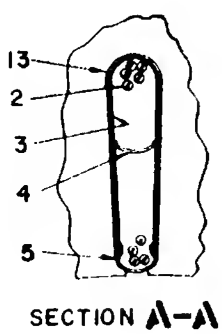
(4) Install screen (47) using screws (46), washers (45), and nuts (44).

j. Install key (38) on shaft (42) and using a suitable arbor, press shaft (42) into main rotor subassembly (37) until main rotor subassembly (37) is against shoulder on shaft (42).

k. Install key (36) on shaft (42). Heat hub (35) in an oven to 450°F (230°C) and install hub (35) on shaft (42) until it bottoms on shaft shoulder.







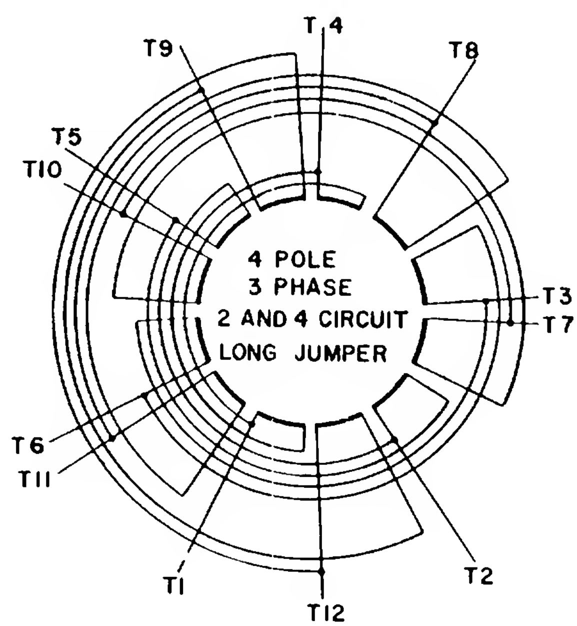


Figure 10-2. Generator G1, Main Stator Rewind Data (Sheet 1 of 3)

1. STATOR CORE
2. MAGNET WIRE 0.064 IN. (16.256 MM) DIA (#14)
3. SLOT CELL INSULATION
4. CENTER SPACER 0.032 IN. (0.813 MM) THICK
5. WEDGE
6. LEAD
7. LEAD
8. INSULATION SLEEVING 0.625 IN. (15.875 MM) ID
9. UNTREATED GLASS TAPE 0.010 x 0.75 IN. (0.254 x 19.05 MM)
10. PHASE INSULATION
11. INSULATION SLEEVING (0.330 IN. 98.382 MM) ID
12. VARNISH
13. INSULATION SLOT CELL
14. VARNISH AIR DRY
15. LEAD
16. LEAD

CONNECTION TABLE		
FIND NO.	LEAD NO.	**B** LEAD LENGTH INCHES (MM)
6	T1, T2, T3, and T7	103.0 MIN (2616.2 MM)
7	T5, T8, T10, and T11	72.0 MIN (1828.8 MM)
15	T4, T6, and T12	43.0 MIN (1092.2 MM)
16	T9	104.0 MIN (2641.6 MM)

Figure 10-2. Generator G1, Main Stator Rewind Data (Sheet 2 of 3)

NOTES:

1. COIL DATA:
   A. WIRE SIZE: 0.064 IN. (1.65 MM) DIA (#14 GA) CLASS 155, TYPE L2.
   B. NUMBER OF WIRES PER TURN: 10.
   C. NUMBER OF TURNS PER COIL: 3.
   D. NUMBER OF WIRES PER COIL: 30.
   E. COIL GROUPING: 12 GROUPS OF 6 COILS.
   F. COIL SPAN: SLOTS 1 AND 13.
2. STATOR WINDING POCEDURE:
   A. WIND COILS TO PROPER SHAPE, SPECIFIED DIMENSIONS AND NUMBER OF TURNS.
   B. HOLD COILS TOGETHER WITH TAPE, INDEX 9.
   C. APPLY SLEEVING, INDEX 11, AND INDEX 8, (LOOSE).
   D. SELECT AN ARBITRARY SLOT ON CORE, INDEX 1, AND INSERT FIRST COIL GROUP WITH START LEAD IN THE BOTTOM OF SLOT NO. 1 AND THE ENDING LEAD IN THE TOP OF SLOT NO. 13. (COIL SPAN 1 AND 13).
   E. INSERT THE NEXT COIL GROUP PER ABOVE GROUPING SEQUENCE. INSERT PHASE INSULATION, INDEX 10, DURING PLACING OF COILS. REPEAT SEQUENCE UNTIL WINDING IS COMPLETE.
   F. MAKE PHASE CONNECTION PER CONNECTION DIAGRAM (HOMOGENEOUS WELD).
   G. CONNECT LEADS, INDEX 6, 7, 15, AND 16 INDIVIDUALLY AND ISOLATED FROM EACH OTHER WITH INDEX 8 PER CONNECTION TABLE (HOMOGENEOUS WELD WIRE ENDS).
   H. APPLY SLEEVING, INDEX 8, OVER LEAD, INDEX 6, 7, 15, AND 16, CONNECTIONS AND PHASE CONNECTIONS.
   J. WRAP WINDING WITH TAPE, INDEX 9.
3. VARNISH AS FOLLOWS:
   STEP 1: PREBAKING -
   PUT INTO OVEN AT 230°F (110°C) HOLD AT TEMPERATURE FOR 4 HOURS. COOL TO APPROXIMATELY 122°F (50°C).
   STEP 2. DIPPING -
   IMMERSE IN VARNISH, MIL-I-24092, UNTIL BUBBLING CEASES. VISCOSITY SHALL BE HELD TO 60 ZAHN SECONDS USING NO. 2 CUP. THIN WITH SOLVENT, MIL-N-15178, TYPE A/B.
   STEP 3: DRAINING -
   DRAIN AND AIR DRY FOR 1 HOUR. ROTATE WOUND APPARATUS TO PREVENT POCKETING THE VARNISH.
   STEP 4: WIPING -
   AFTER DRAINING BUT BEFORE BAKING, THE METAL SURFACES OF THE ARMATURE, THE BORE OF THE STATOR AND THE POLE FACES OF THE FIELD STRUCTURE SHALL BE WIPED WITH A CLOTH MOISTENED WITH SOLVENT, MIL-N-15178, TYPE A/B.
   STEP 5: BAKING -
   BAKE IN CIRCULATING TYPE, FORCED EXHAUST, BAKING OVEN AT TEMPERATURE OF 329°F (165°C).
   STEP 6: COOLING -
   REMOVE FROM OVEN AND COOL TO APPROXIMATELY 122°F (50°C).
   STEP 7: SECOND TREATMENT (DIP IN OPPOSITE DIRECTION) - REPEAT STEPS 2 (IMMERSE FOR 1 MINUTE), 3, 4, 5, AND 6.
   STEP 8: THIRD TREATMENT (DIP IN ORIGINAL DIRECTION) - REPEAT STEPS 2 (IMMERSE FOR 1 MINUTE), 3, 4, 5, AND 6.
4. STAMP PART NUMBER AS SHOWN BELOW PER MIL-STD-130, 0.12 IN. (3.05 MM) MIN HEIGHT, USING WHITE ENAMEL PAINT.
   30554 ASSY 70-4513
   MFG (MFG CODE)
5. AFTER REWINDING, PERFORM INSPECTION SPECIFIED IN PARAGRAPH 10-6, STEPS K AND O.

Figure 10-2. Generator G1, Main Stator Rewind Data (Sheet 3 of 3)

Table 10-1. Generator Output Lead Lengths

LEAD NUMBER	LEAD LENGTH IN INCHES (MILLIMETERS)	
	TOLERANCE	
	INCHES +0.005 -0.000	MILLIMETERS +0.1270 -0.000
T1	103	2616.2
T2	103	2616.2
T3	103	2616.2
T4	43	1092.2
T5	72	1828.8
T6	43	1092.2
T7	103	2616.2
T8	72	1828.2
T9	104	2641.6
T10	72	1828.8
T11	72	1828.8
T12	43	1092.2

l. Install key (34) and exciter rotor assembly (33) on shaft (42). Using a suitable arbor, press spacer (32) into place.

m. Assemble rectifier assembly (12) and position on shaft (42). Align hole for setscrew (11) with hole in shaft (42).

n. Install setscrew (11 and 31) and tighten to 20 foot-pounds (27 Newton-meters) torque.

o. Apply insulation sleeving to main rotor subassembly (37) leads R4 and R5. Position lead R5 at 3 o'clock and lead R4 at 9 o'clock on shaft (42) looking from bearing end of shaft. Tape leads to shaft at two evenly spaced positions between the main rotor subassembly (37) and exciter rotor assembly (33). Brush coat tape with varnish. Position leads R4 and R5 through two holes provided in exciter rotor assembly (33) and insulator (30). Cut leads long enough to connect a rectifier assembly (12). Strip lead insulation back 0.375 inch (9.525 mm) and install terminal lugs on leads. Connect leads R4 and R5 to rectifier assembly.

p. Position leads R1, R2, and R3 from exciter rotor assembly (33) through insulator (30) holes and cut leads long enough to connect to rectifier assembly (12). Strip lead insulation back 0.375 inch (9.525 mm) and install terminal lugs and connect leads R1, R2, and R3 to rectifier assembly (12).

q. Using a suitable arbor, press bearing (8) against shoulder on shaft (42). Install snap ring (7) on shaft (42).

r. Place assembled shaft in a suitable dynamic balancing machine. Balance assembled shaft in two planes. Rotate shaft at 600 to 800 rpm and balance shaft to 3.5 inch-ounce (0.3 Newton-meters). To install balance weight, place weight in proper position on rotor and transfer drill two 0.2570 inch (6.785 mm) holes, 1 inch (25.4 mm) deep for each weight. Tap hole for 5/16-18UNC-2B thread. Secure weights (41) with screws (39) and lockwasher (40). Trim balance to 0.5 inch-ounce (0.04 Newton-meters) by removing metal from steel core of main rotor subassembly (37).

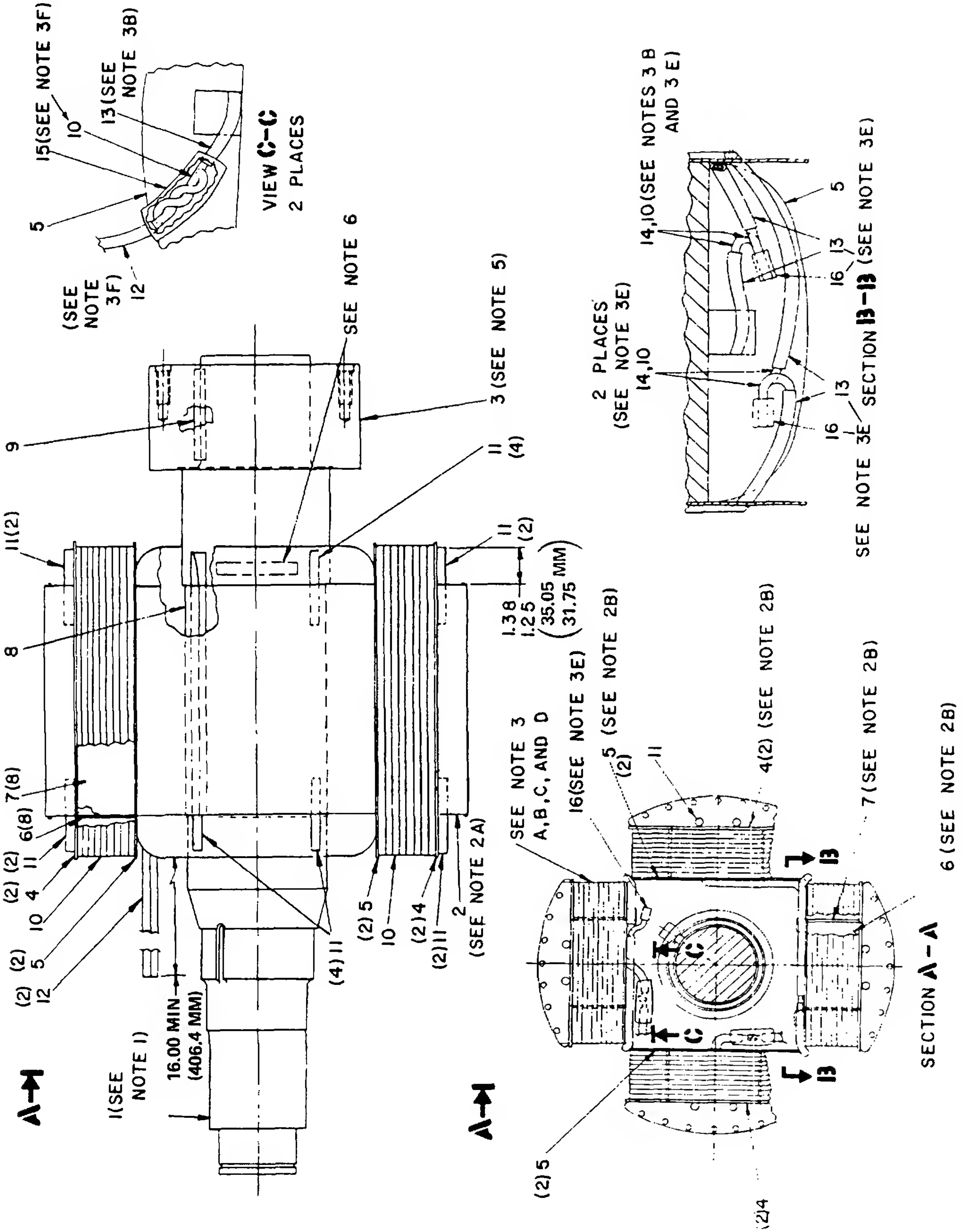


Figure 10-3. Main Rotor Rewind Data (Sheet 1 of 2)

1. SHAFT
2. ROTOR CORE
3. DRIVE HUB COUPLING
4. POLE INSULATION
5. POLE INSULATION
6. POLE INSULATION
7. POLE INSULATION
8. KEY
9. KEY
10. MAGNET WIRE HPT 0.085 x 0.200 IN.(2.159 X 5.08 MM)
11. PIN
12. LEAD
13. INSULATION SLEEVING 0.234 IN.ID (5.969 MM)
14. EPOXY COMPOUND
15. INSULATION SLEEVING
16. SPLICE
17. SOLDER

NOTES:

1. PRESS FIT SHAFT, INDEX 1, INTO CORE, INDEX 2 TO SHOULDER ON SHAFT INDEX 1.
2. INSULATING:
   A. APPLY EPOXY, INDEX 14, TO POLE BOTTOM, POLE SIDES AND POLE ENDS.
   B. INSTALL INSULATION, INDEX 5, ON BOTTOM POLE SIDES, INSTALL INSULATION, INDEX 4.
3. WINDING:
   A. ADJUST WIRE TENSION TO 70 LBS (32 KG).
   B. APPLY SLEEVE, INDEX 13, TO START LEAD OF EACH COIL.
   C. WIND THE FIRST LAYER WITH 10 TURNS TO FILL THE WINDING SPACE. FORM THE COIL SIDES WITH A FIBRE BLOCK TO OBTAIN FLAT AND TIGHT WINDING. DO NOT FORM COIL ENDS. APPLY EPOXY, INDEX 14.
   D. CONTINUE WINDING COMPLETE COIL AS DESCRIBED IN WINDING NOTE 3B, MAKING SURE TO APPLY EPOXY, INDEX 14, TO COVER ALL TURNS AND TO FILL ALL VOIDS THROUGH THE ENTIRE WINDING. THIS WILL REQUIRE BRUSHING EPOXY ON ALL LAYERS. FORM COIL SIDES WHILE WINDING TO PRODUCE FLAT SIDES. WIND EACH COIL WITH 160 TURNS PER LAYER, 4 COILS.
   E. APPLY SLEEVING, INDEX 13 TO ENDING LEAD OF EACH COIL. SELECT START LEAD OF ARBITRARY COIL AND CONNECT COILS IN SERIES, HOMOGENEOUS WELD, AND USE PARALLEL SPLICE, INDEX 16.
   F. CONNECT LEADS, INDEX 12, TO REMAINING TWO LEADS, SOLDER USING SOLDER, INDEX 17.
4. BAKE COMPLETED ROTOR FOR A MINIMUM OF 24 HOURS AT 325° TO 350°F (165° TO 175°C).
5. HEAT HUB, INDEX 3, TO 400°F (204°C) THEN SHRINK FIT ON SHAFT, INDEX 1, TO SHOULDER.
6. STAMP PART NUMBER AS SHOWN BELOW PER MIL-STD-130, 0.12 IN. (3.05 MM) MINIMUM HEIGHT, USING WHITE ENAMEL PAINT.
   30554 ASSY 70-4509
   MFG (MFG CODE)
7. AFTER REWINDING, PERFORM INSPECTION SPECIFIED IN PARAGRAPH 10-6, STEPS I AND P.

Figure 10-3. Main Rotor Rewind Data (Sheet 2 of 2)

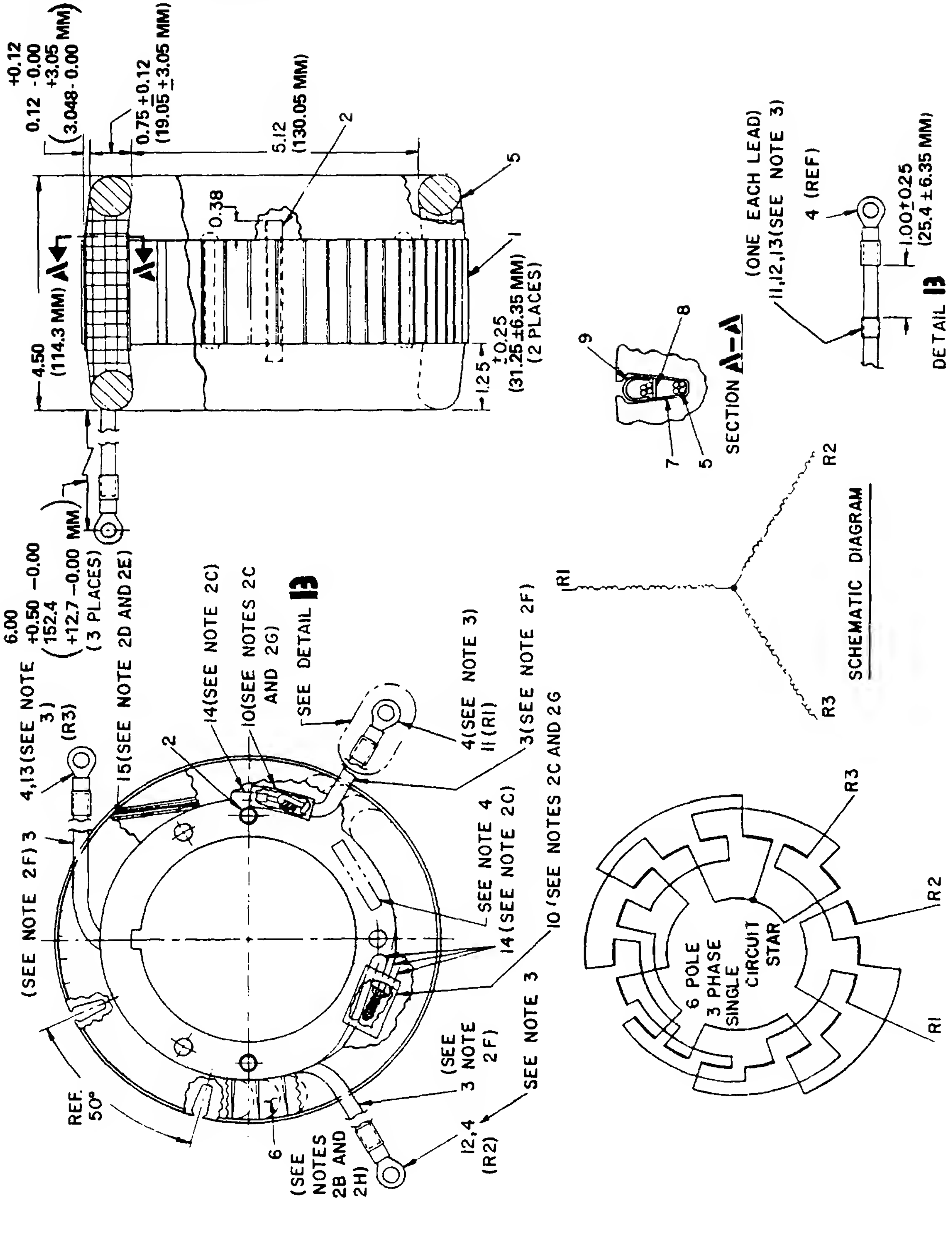


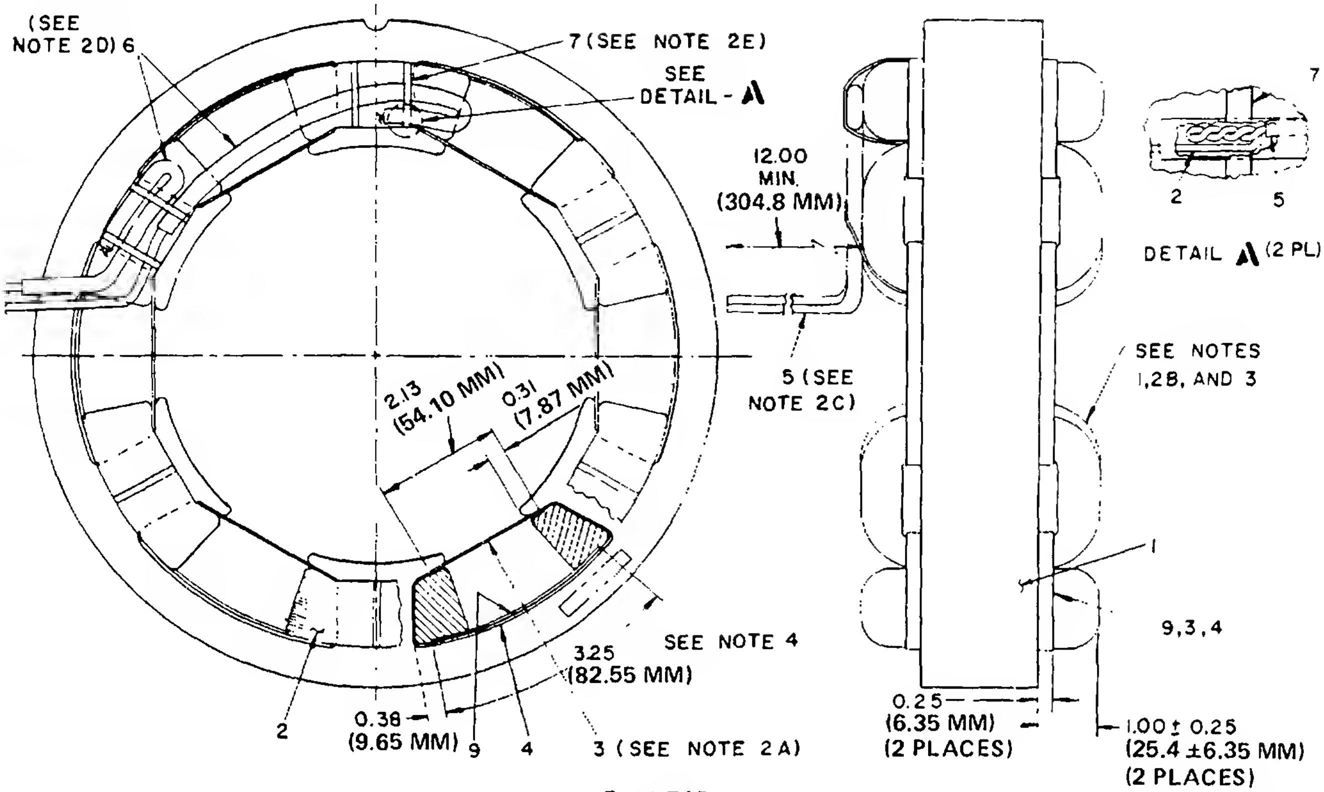
Figure 10-4. Exciter Rotor Rewind Data (Sheet 1 of 2)

1. ROTOR CORE
2. INSULATION
3. LEAD
4. TERMINAL LUG
5. MAGNET WIRE 0.040 IN. (1.02 MM) DIA (#18)
6. UNTREATED GLASS TAPE 0.010 X 0.75 IN.(0.254 X 19.05 MM)
7. SLOT CELL INSULATION
8. CENTER SPACER 0.032 IN. (0.812 MM) THICK
9. WEDGE
10. INSULATION SLEEVING 0.330 IN. (8.382 MM) ID
11. WIRE MARKER
12. WIRE MARKER
13. WIRE MARKER
14. INSULATION SLEEVING 0.106 IN. (2.692 MM) ID
15. PHASE INSULATION
16. VARNISH

NOTES:

1. COIL DATA:
   A. WIRE SIZE: 0.040 DIA (#18 GA) CLASS 155, TYPE L2.
   B. NUMBER OF WIRES PER TURN: 6.
   C. NUMBER OF TURNS PER COIL: 3.
   D. NUMBER OF WIRES PER COIL: 18.
   E. COIL GROUPING: 18 GROUPS OF 2 COILS.
   F. COIL SPAN: SLOTS 1 AND 6.
2. ROTOR WINDING PROCEDURE:
   A. WIND COILS TO PROPER SHAPE, SPECIFIED DIMENSIONS AND NUMBER OF TURNS.
   B. HOLD COILS TOGETHER WITH TAPE, INDEX 6.
   C. APPLY SLEEVING, INDEX 14 AND 10 (LOOSE).
   D. SELECT AN ARBITRARY SLOT ON CORE, INDEX 1, AND INSERT FIRST COIL GROUP WITH START LEAD IN THE BOTTOM OF SLOT NO. 1 AND THE ENDING LEAD IN THE TOP OF SLOT NO. 6.
   E. INSERT THE NEXT COIL GROUP PER ABOVE GROUPING SEQUENCE. INSERT PHASE INSULATION, INDEX 15, DURING PLACING OF COILS. REPEAT SEQUENCE UNTIL WINDING IS COMPLETE.
   F. MAKE PHASE CONNECTION AND CONNECT LEADS, INDEX 3 PER CONNECTION DIAGRAM, (HOMOGENEOUS WELD).
   G. APPLY SLEEVING, INDEX 10, OVER LEAD, INDEX 3 CONNECTIONS AND PHASE CONNECTION.
   H. WRAP WINDING WITH TAPE, INDEX 6.
   I. VARNISH, REFER TO FIGURE 10-2, NOTE 3.
3. CUT LEADS, INDEX 3, AND INSTALL TERMINALS, INDEX 4, AND WIRE MARKERS, INDEX 11, 12, AND 13, TO DIMENSIONS SHOWN. CRIMPING OF TERMINALS TO MEET THE REQUIREMENTS AND TESTS OF MIL-T-7928. HEAT WIRE MARKERS, INDEX 11, 12, AND 13 TO 392°F (200°C) FOR 5 SECONDS.
4. STAMP PART NUMBER AS SHOWN BELOW PER MIL-STD-130, 0.12 IN. (3.05 MM) MINIMUM HEIGHT, USING WHITE ENAMEL PAINT.
   30554 ASSY 70-4511
   MFG (ADD MFG CODE)
5. AFTER REWINDING, PREFORM INSPECTION SPECIFIED IN PARAGRAPH 10-6, STEPS M AND Q.

Figure 10-4. Exciter Rotor Rewind Data (Sheet 2 of 2)



1. STATOR CORE
2. MAGNET WIRE 0.057 IN. (1.448 MM) DIA (#15)
3. INSULATION PLATE
4. SLOT CELL INSULATION
5. LEAD
6. INSULATION SLEEVING 0.330 IN. (8.382 MM) ID
7. UNTREATED GLASS TAPE 0.010 X 0.75 IN. (0.254 X 19.05 MM)
8. VARNISH
9. SLOT CELL INSULATION

NOTES:

1. COIL DATA:
   A. WIRE SIZE: 0.057 IN. (1.448 MM) DIA (#15 GA), CLASS 155, TYPE L2.
   B. NUMBER OF POLES: 6.
   C. NUMBER OF TURNS PER COIL: 85.
2. STATOR WINDING PROCEDURE:
   A. INSULATE STATOR CORE, INDEX 1, COMPLETE USING INSULATION PLATE, INDEX 3, AND SLOT CELL INSULATION, INDEX 4 AND 9.
   B. WIND STATOR COMPLETE, 6 COILS CONNECTED IN SERIES.
   C. CONNECT LEADS, INDEX 5, TO COILS, SEE DETAIL A, HOMOGENEOUS WELD.
   D. APPLY SLEEVING, INDEX 6.
   E. TIE LEADS AND END LOOPS WITH TAPE, INDEX 7.
3. VARNISH, REFER TO FIGURE 10-2, NOTE 3.
4. STAMP PART NUMBER AS SHOWN BELOW PER MIL-ST-130, 0.12 IN. (3.05 MM) MINIMUM HEIGHT, USING WHITE ENAMEL PAINT.
   30554 ASSY 70-4514
   MFG (MFG CODE)
5. AFTER REWINDING, PERFORM INSPECTION SPECIFIED IN PARAGRAPH 10-6, STEPS N AND R.

Figure 10-5. Exciter Stator Rewind Data

s. Place rotor and shaft assembly (1) on a bench: rest main rotor subassembly (37) on a cushion material to prevent damage. Allow hub (35) to hang over side of bench.

NOTE

The fan is secured to shaft coupling to protect it from damage and for ease of handling.

t. Position fan (6) on shaft couplings (5) and secure fan to shaft couplings with two suitable screws and nuts 180 degrees apart. Install fan (6), shaft couplings (5), retainer (4), and clip locks (3) on shaft (42) and secure with screws (2), leaving two screws (2) 180 degrees apart out. Tighten screws to 50 foot-pounds (68 Newton-meters) torque. Install lifting fixture (refer to table 2-3) and secure with two 0.500 - 20 x 3.00 screws to main rotor and shaft assembly (1).

u. Using a lifting device (capable of lifting 3-tons (2.7 t) minimum) and cable hook, position main stator and frame assembly (43) in a vertical position resting the endbell (67) on wooden blocks. Place blocks under the generator mounting plates (84) to prevent generator from tipping over.

CAUTION

Exercise extreme care when installing main rotor and shaft assembly into main stator and frame assembly to prevent damage to windings.

v. Connect lifting device (capable of lifting 3-tons (2.7 t) minimum) to lifting fixture in main rotor and shaft assembly (1) into main stator and frame assembly (43). Remove lifting device and lifting fixture. Install two remaining screws (2) and tighten screws to 50 foot-pounds (68 Newton-meters) torque. Bend up all corners of clip locks (3) to prevent screws from turning.

w. Connect a shipping block (refer to table 2-3) across engine mounting end of generator to hold main rotor and shaft assembly in center position and to prevent assembly from sliding out of frame when moving generator.

x. Lower generator to horizontal position. Place tag on generator. Stator fan is mounted to shaft coupling with shipping screws and nuts only. Remove screws and nuts prior to installation.

10-9. HIGH POTENTIAL TEST. Perform the high potential test as follows:

NOTE

This test is applicable to rewound components only.

a. Isolate the generator and exciter armature and field windings from all external circuits including rotating rectifiers. Be sure generator frame and test apparatus are properly grounded to an external ground (in addition to unit frame). Connect one end of each armature winding together to form a single circuit for testing.

WARNING

Ground generator and exciter field windings securely when testing generator armature windings.

b. Connect the high voltage lead from the test apparatus to the generator armature winding. Bring the voltage up to 1480 volts in not less than 10 seconds nor more than 30 seconds. Apply

this voltage for 1 minute, then gradually reduce to zero in not less than 5 seconds. Ground high voltage lead before removing to discharge winding.

WARNING

Ground generator armature and exciter windings securely when testing generator field windings. Ground generator field and generator armature windings securely when testing exciter windings.

c. Repeat step b, above for the generator field and exciter windings, except that the maximum voltage shall be between 1500 to 3500 volts.

d. Electrical windings shall be able to withstand the following voltages applied for 1 minute between the windings and ground: generator armature windings - 1480 volts at 60 Hertz; generator field and exciter windings - 1500 to 3500 volts at 60 Hertz.

10-10. INSTALLATION. Install the generator as specified in Chapter 2.

CHAPTER 11

MAINTENANCE OF ENGINE

Section I. MAINTENANCE OF TURBOCHARGER

11-1. GENERAL. The turbocharger is mounted on the exhaust manifold. The turbocharger consists of a turbine wheel and a compressor impeller mounted on a common rotating shaft, a bearing housing, compressor cover, and compressor back plate. The turbocharger, which is driven by the engine exhaust gases, draws in ambient air, compresses the air, and directs it into the engine. This process supercharges the engine which results in a greater power output.

11-2. REPAIR.

a. Fabricate the special fixture, fixture adapter supporting screw, wood dowel, and wrench shown in table 2-3. These tools are used for disassembly of rotating parts.

b. Remove turbocharger in accordance with the Operator and Organizational Maintenance Manual.

c. Remove air cleaner seals (1 and 2, figure 11-1) and coupling (3) from the turbocharger assembly (4).

d. Measure wheel (14) end clearance. End clearance must be 0.006 to 0.011 inch (0.152 to 0.279 mm). If the clearance is excessive, or if either the shaft and wheel assembly (26) or wheel (14) has rubbed against the housing assembly (31) or shroud (27), then either the bearings (24) and/or thrust bearing (22) and collar (21) must be replaced.

e. Punch mark housing assembly (7), housing assembly (31), and housing (11) to ensure correct positioning upon reassembly.

f. Remove nameplate (5) only if damaged.

g. Remove clamp (6) and remove housing (7).

h. Remove bolts (8), plate (9), and plate (10) from housing (11).

i. Remove cartridge assembly (12) from housing (11).

j. Remove nut (13).

k. Bolt fixture adapter to fixture (see figure 11-2).

CAUTION

Proper installation of supporting screw is important so as to allow an unobstructed pressing action on shaft and still prevent turbine wheel from being damaged by striking against fixture base.

l. Thread supporting screw into base of fixture to contain turbine wheel and shaft when pressed from wheel (14). Leave a space between end of screw and turbine wheel. Approximately 1-1/2 inch (12.7 mm) of shaft and turbine wheel movement is required to free them from wheel.

m. Position compressor end of housing in a hot oil bath so that only the wheel (14) is immersed.

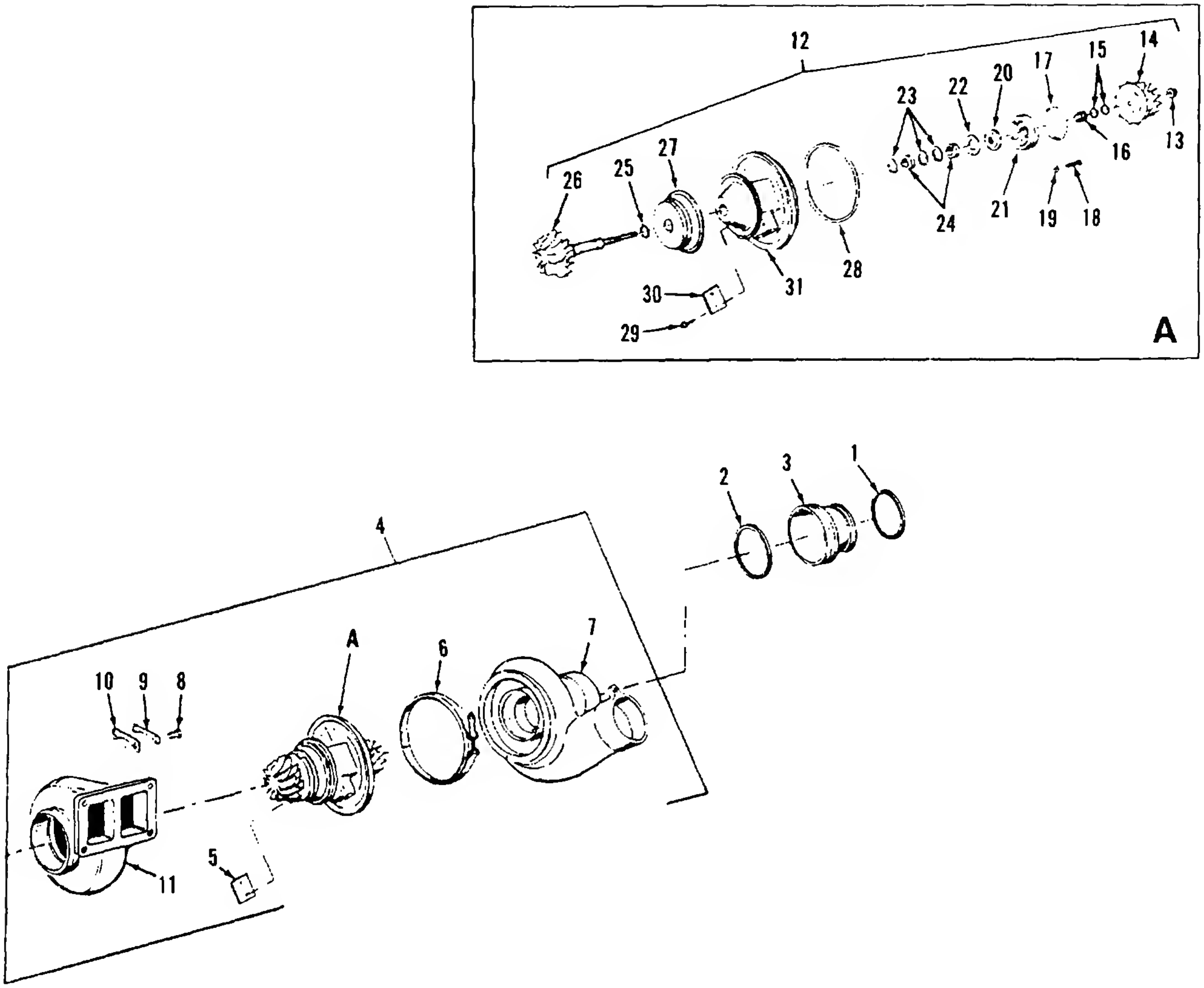
n. Heat wheel to 350°F (175°C) for not longer than 10 minutes.

o. Remove unit from oil bath and press shaft and turbine wheel (26) as a unit from wheel (14) (see figure 11-2).

p. Remove rings (15), spacer (16), and seal (17).

q. Remove screw (18) to remove plate (19).

r. Remove thrust plate assembly (20) and collar (21) using the wooden dowel (see figure 11-3).



1. SEAL
2. SEAL
3. COUPLING
4. TURBOCHARGER ASSY
5. NAMEPLATE
6. CLAMP
7. HOUSING ASSY
8. BOLT
9. PLATE
10. PLATE
11. HOUSING
12. CARTRIDGE ASSY
13. NUT
14. COMPRESSOR WHEEL
15. RING
16. SPACER
17. SEAL
18. SCREW
19. PLATE
20. THRUST PLATE ASSY
21. COLLAR
22. BEARING
23. RING
24. BEARING
25. RING
26. SHAFT AND TURBINE WHEEL ASSY
27. SHROUD
28. SEAL
29. SCREW
30. NAMEPLATE
31. HOUSING ASSY

Figure 11-1. Turbocharger, Exploded View

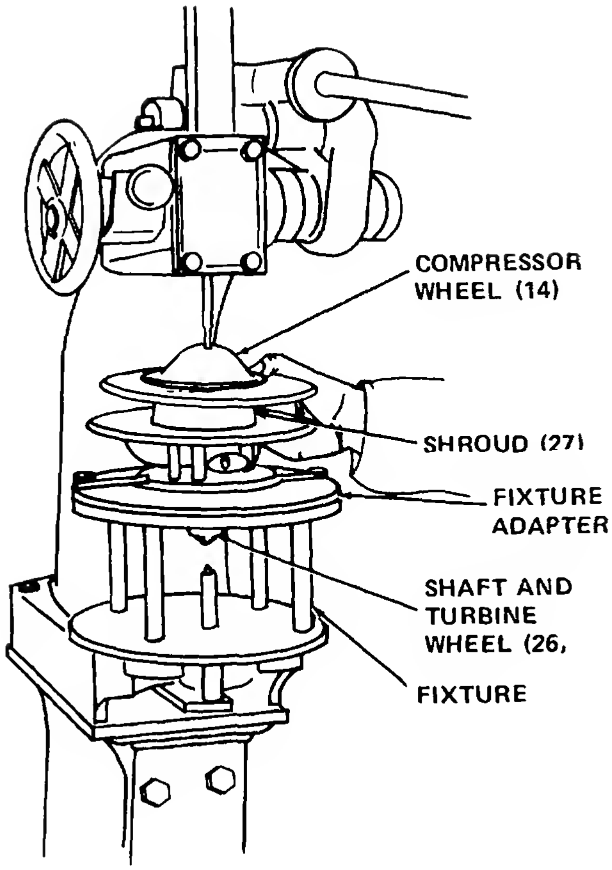


Figure 11-2. Pressing Shaft and Wheel Assembly

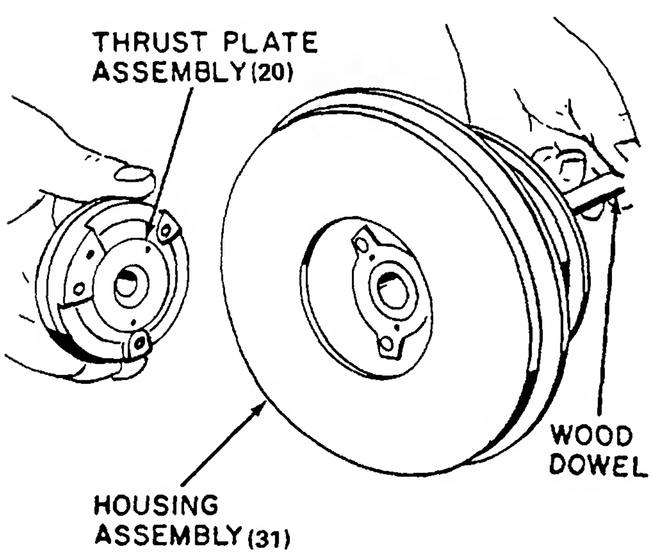


Figure 11-3. Thrust Plate, Removal

s. Remove bearing (22), rings (23), and bearings (24).

t. Remove ring (25) with shaft and wheel assembly (26). Remove ring (25).

u. Remove shroud (27) and seal (28) from the housing assembly (31).

v. Remove nameplate (30) and screw (29) from housing assembly (31) only if damaged.

w. Repair damaged threaded holes for oil pressure line flange bolts and for drain line flange bolts in the housing assembly by retapping holes to clean out burrs and other obstructions.

x. Clean oil passages in housing assembly using a pipe cleaner.

CAUTION

Rotating components must be thoroughly cleaned to maintain critical balance of turbocharger. Do not use a wire brush or wheel on any parts.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

y. The turbine wheel (26) must be cleaned thoroughly to remove all carbon deposits. It may be necessary to soak wheel in solvent, P-D-680, Type II, for at least 1 hour to remove hardened carbon deposits. Scrape off loosened particles with a stiff brush or a specially shaped piece of wood. If turbine wheel is covered with soot only, use cleaning solvent and a stiff brush, rinse with clean water, and dry thoroughly.

z. Repair by replacement of any worn, damaged, or defective components. Refer to table 1-3 and, using a suitable

micrometer and feeler gage, check parts for dimensional tolerances. Replace parts that do not meet dimensional tolerances.

aa. If nameplate (30) was removed, install nameplate on housing assembly (31) using screw (29).

ab. Install seal (28) and shroud (27) onto housing (31).

ac. Install ring (25) with shaft and wheel assembly (26).

ad. Install bearings (24), rings (23), and bearing (22), and install seal (17) on collar (21).

ae. Install thrust plate assembly (20) and collar (21). Install collar (21) so that oil hole aligns with oil hole in housing (31).

af. Install plate (19) using screw (18). Torque screw (18) to 30 to 40 inch-pounds (3.4 to 4.5 Newton-meters).

ag. Install spacer (16), and rings (15).

ah. Install shaft and wheel assembly (26) in housing assembly (31).

ai. Install compressor wheel (14) on shaft and turbine wheel assembly (26) as follows:

(1) Place shaft and wheel assembly end of the center housing (31) in turbine fixture.

(2) Place wheel (14) in an oil bath, and heat wheel to a maximum of 350°F (175°C) for not longer than 10 minutes.

(3) Remove wheel (14) from oil bath, immediately install wheel (14) onto shaft and wheel assembly (26) and install old nut (13). Torque nut (13) to 120 inch-pounds (13.6 Newton-meters).

(4) Allow wheel (14) to cool to less than 150°F (65°C), then remove old nut (13).

(5) Lubricate threads of shaft and wheel assembly (26) and a new nut (13) with lubricating oil, MIL-L-2104.

(6) Install new nut (13), and torque to 30 inch-pounds (3.4 Newton-meters), then tighten an additional 120 degrees.

aj. Install cartridge assembly (12) into housing (11).

ak. Coat threads of bolts (8) with anti-seize compound (MIL-C-47167). Install plates (9 and 10) using bolts (8). Torque bolts (8) to 160 to 180 inch-pounds (18 to 20.3 Newton-meters).

al. If removed, install nameplate (5).

am. Install housing (7) and secure with clamp (6).

an. Install coupling (3) and seals (1 and 2) onto turbocharger assembly (4).

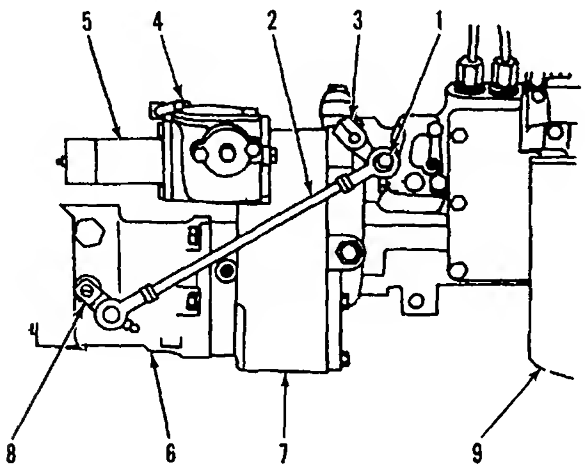
ao. Lubricate the turbocharger at the oil pressure hole prior to installing the turbocharger. This will prevent a dry start or premature failure of the turbocharger. Install turbocharger in accordance with the Operator and Organizational Maintenance Manual.

Section II. MAINTENANCE OF GOVERNOR

11-3. GENERAL. The governor which is mounted on the side of the fuel injection pump ensures that generator output frequency (or function of engine speed) will remain reasonably constant during allowable changes in the load circuit. To accomplish this requirement, the governor senses engine speed by means of spring-loaded flyweights (centrifugal ballhead) and

than translates these, through a linkage translator into variations in the amount of fuel oil applied to the engine.

11-4. TESTING. The governor must be tested while on the engine. To test the governor, refer to figure 11-4 and proceed as follows:



1. BOLT
2. LINKAGE ROD
3. FUEL INJECTION PUMP LEVER
4. SHUTOFF LEVER
5. SHUTOFF SOLENOID
6. GOVERNOR
7. COVER
8. LEVER
9. FUEL INJECTION PUMP

Figure 11-4. Governor, Testing

a. With the engine at operating temperature and running normally, momentarily position shutoff lever (4) to shutoff position.

b. When the engine speed starts to decrease, release shutoff lever. If the governor is operating correctly, there should be a rapid return to normal engine speed with only a small amount of overshoot (engine runs faster than normal).

c. If engine does not return to normal speed upon release of shutoff lever, shut down engine and disconnect linkage (2) between governor (6) and fuel injection pump (9).

d. Start engine and bring to normal operating RPM by manual operation of lever (3). Move lever (3) in such a manner as to decrease generator output frequency by about 5 Hertz.

e. Governor control lever (8) should duplicate movement of lever (3) except in opposite direction. If lever (8) does not respond as required, governor is probably defective and must be removed, repaired, and, if required, overhauled.

11-5. REPAIR. Repair of the governor consists of determining the cause of a particular malfunction and disassembling and/or adjusting to the extent necessary to correct the malfunction. To determine the cause of the malfunction refer to table 2-4 and, for overhaul procedures, refer to paragraph 11-6.

NOTE

When troubleshooting apparent governor malfunctions make certain that binding in linkages, improper engine operation, or rexcessive loading is not the cause before proceeding to troubleshooting table 2-4. Governor troubles such as erratic operation and poor repeatability are frequently caused by dirty oil. Remove governor and clean thoroughly (refer to paragraph 11-6).

11-6. OVERHAUL. Overhaul consists of disassembly, cleaning, inspection, assembly, and adjusting the governor.

NOTE

Table 2-1 lists the special tools necessary to overhaul the governor.

a. Disassembly. To disassemble the governor, refer to figure 11-5 and proceed as follows:

NOTE

Prior to removing speed adjusting screws, needle valve, and droop bracket, record their position for use during reassembly.

(1) Clamp governor tightly in vise using soft copper jaws below the point where the case joins the base. Remove speed droop bracket screw (14) and associated hardware (15, 16, 17, 99, 100, and 101).

(2) Remove three screws (2), washers (3) and slowly take off cover (1) so that vertical return spring (9) which is under compression - does not spring clear.

(3) Using appropriate Allen wrench, remove two screws (12), two washers (13), and, using a rawhide mallet, tap subcap (11) free of gasket (20).

(4) Lift up free end of terminal lever (21) to expose screws (22). Remove screws (22) and washers (23).

(5) Pull out both terminal shafts (24) and two sets of oil seal rings (25) from terminal shaft sleeve (44).

(6) Lift out terminal lever (21) along with parts (26, 27, and 28). Slide pivot pin (29) out of lever (21).

(7) If required, unscrew nut (27) to free parts (26 and 28).

(8) Unscrew speed adjust sleeve assembly (30) and remove with washer (31).

(9) Remove U-shaped pin (32) and remove floating lever (33).

(10) Remove pin (35) and slide speed adjust shaft (37) out of case (96).

(11) Lift out speed adjust lever (34) and torsion spring (36).

(12) Unscrew short droop adjust assembly (38) and remove with washer (39).

(13) If required, unscrew elastic stop nut (41) to remove droop link assembly (40). Remove speed droop shaft assembly (43).

(14) If required replace terminal shaft sleeves (44).

(15) Unscrew elastic stop nut (47) and remove with copper washer (48).

(16) Remove power piston stop screw (45) and bushing stop (46).

(17) Lift out power piston (49), buffer piston (50), buffer springs (51 and 52), spring seat (53), and snap ring (54) as an assembly.

NOTE

To further disassemble this assembly, use snap ring pliers and remove snap ring (54).

(18) Check for dirt accumulation by holding the governor drive shaft and turning the ballhead assembly (63 through 70) against its internal stop. Repeat in the opposite direction. Travel should be smooth and approximately 22 degrees in each direction. If the ballhead does not come up solidly against both stops or does not return promptly to midposition when released, remove and replace the ballhead assembly. Using pilot valve wrench (see table 2-1), wedge it between coils of speed spring assembly (55) and spring seat (56) as shown in figure 11-6. Hold the spring fork and bend spring towards open end of bottom coil. At the same time, turn spring to disengage coil from seat lip.

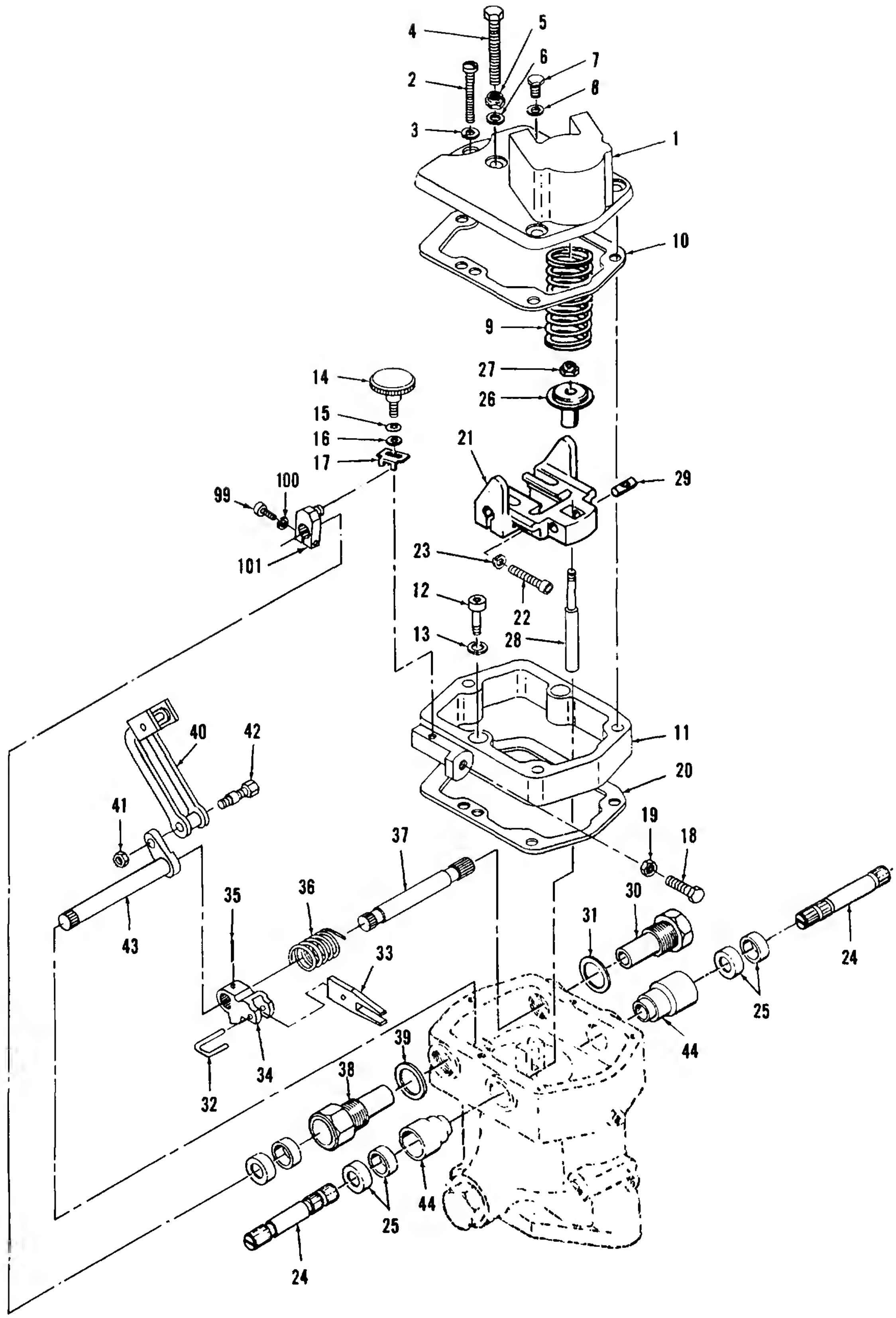


Figure 11-5. Governor, Exploded View (Sheet 1 of 3)

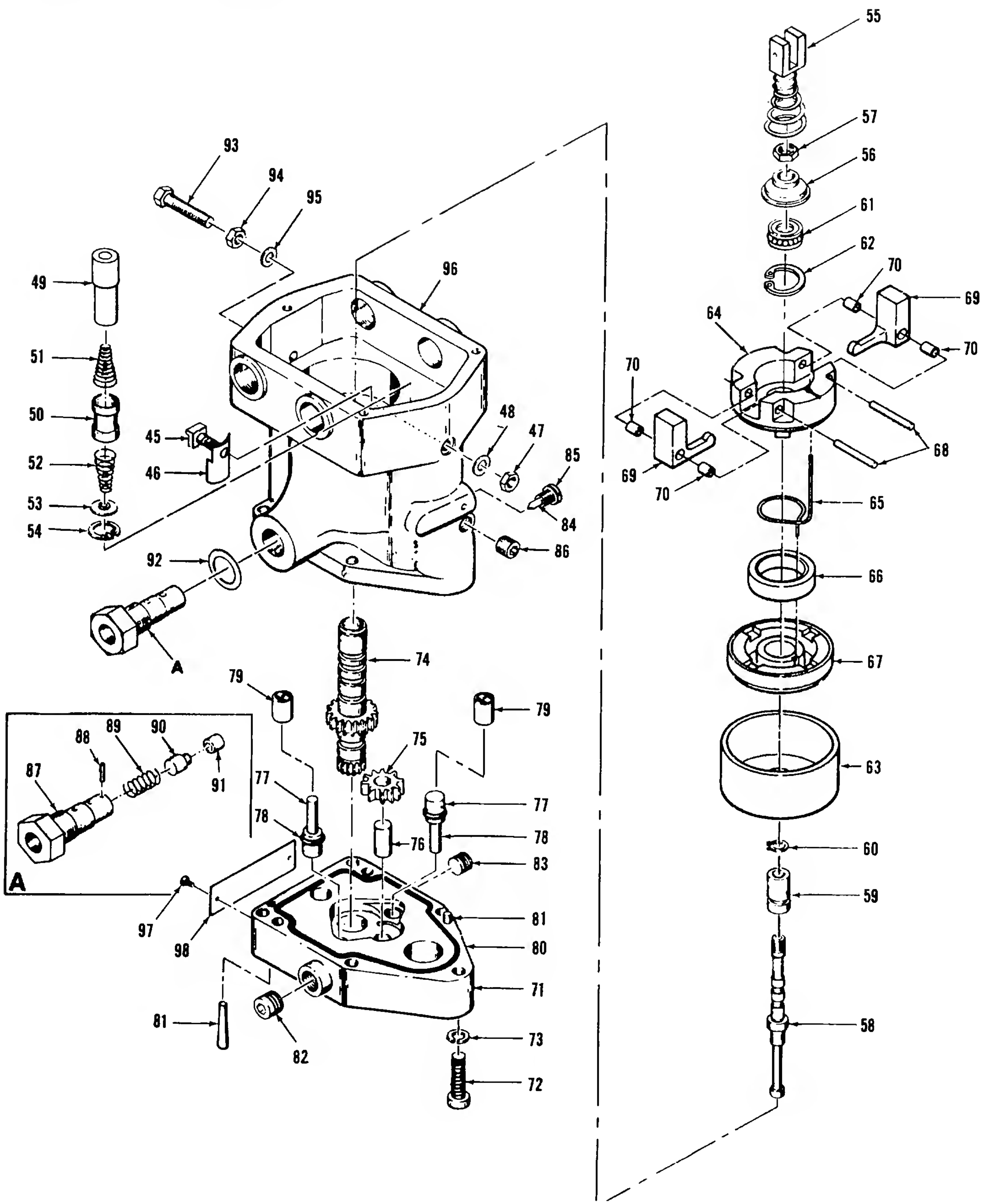


Figure 11-5. Governor, Exploded View (Sheet 2 of 3)

1. COVER
2. SCREW
3. WASHER
4. SCREW
5. ELASTIC HEX NUT
6. WASHER
7. HEX SCREW
8. WASHER
9. VERTICAL RETURN SPRING
10. GASKET
11. SUBCAP
12. CAPSCREW
13. WASHER
14. SPEED DROOP BRACKET SCREW
15. WASHER
16. WASHER
17. BRACKET
18. DROOP ADJUSTING SCREW
19. HEX NUT
20. GASKET
21. TERMINAL LEVER
22. SCREW
23. WASHER
24. TERMINAL SHAFT
25. OIL SEALS
26. SPRING SEAT
27. NUT
28. POWER PISTON STRUT
29. PIVOT PIN
30. SPEED ADJUST SLEEVE ASSY
31. COPPER WASHER
32. PIN
33. FLOATING LEVER
34. SPEED ADJUSTING LEVER
35. COTTER PIN
36. TORSION SPRING
37. SPEED ADJUSTING SHAFT
38. SHORT DROOP ADJUSTING ASSY
39. COPPER WASHER
40. DROOP LINK ASSY
41. ELASTIC STOP NUT
42. DROOP BRACKET SCREW
43. SPEED DROOP SHAFT ASSY
44. TERMINAL SHAFT SLEEVE
45. POWER PISTON STOP SCREW
46. BUSHING STOP
47. ELASTIC STOP NUT
48. COPPER WASHER
49. POWER PISTON
50. BUFFER PISTON
51. BUFFER SPRING
52. BUFFER SPRING
53. BUFFER SPRING SEAT
54. RETAINING SNAP RING
55. SPEEDER SPRING ASSY
56. SPRING SEAT
57. PILOT VALVE PLUNGER NUT
58. PILOT VALVE PLUNGER
59. COMPENSATING BUSHING
60. RETAINING SNAP RING
61. THRUST BEARING
62. RETAINING RING
63. BALLHEAD COVER
64. BALLHEAD
65. TORSION SPRING
66. BALL BEARING
67. BALLHEAD DRIVE CUP
68. FLYWEIGHT PIN
69. FLYWEIGHT
70. NEEDLE BEARING
71. BASE
72. SCREW
73. WASHER
74. PILOT VALVE BUSHING
75. IDLER GEAR
76. IDLER GEAR STUD
77. DIRECTIONAL PLUG
78. PACKING
79. CHECK VALVE
80. OIL SEAL RING
81. DOWEL PIN
82. PIPE PLUG
83. PIPE PLUG
84. NEEDLE VALVE
85. PACKING
86. PLUG
87. RELIEF VALVE SLEEVE
88. PIN
89. SPRING
90. RELIEF VALVE PLUNGER
91. RELIEF VALVE STOP SLEEVE
92. RELIEF VALVE GASKET
93. HIGH SPEED STOP SCREW
94. ELASTIC STOP NUT
95. COPPER WASHER
96. CASE
97. SCREW
98. NAMEPLATE
99. SCREW
100. WASHER
101. SPEED DROOP LEVER ASSY

Figure 11-5. Governor, Exploded View (Sheet 3 of 3)

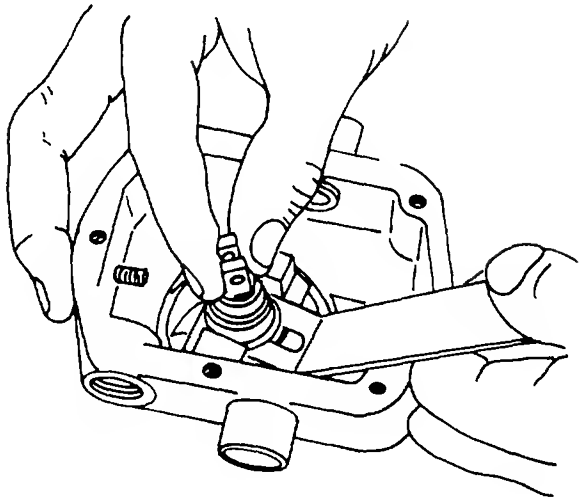


Figure 11-6. Governor Speeder Spring Removal

(19) Hold spring seat (56, figure 11-5) with short end of pilot valve wrench and using a 5/16 inch socket wrench, remove pilot valve plunger locknut (57) (refer to figure 11-7).

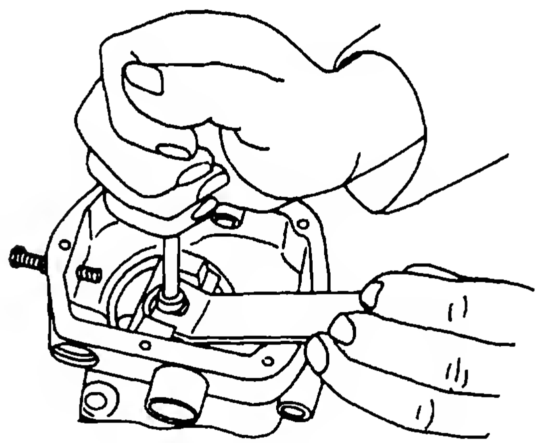


Figure 11-7. Governor Pilot Valve Disassembly

(20) Place a small screwdriver in the slot at the top of pilot valve plunger (58, figure 11-5) and screw pilot valve plunger down and out of spring seal (56). Lift pilot valve plunger clear of governor and remove spring seat (56) and thrust bearing assembly (61).

NOTE

The thrust bearing consists of an upper and lower race and a bearing assembly.

(21) Remove snap ring (62) and lift out ballhead parts (63 through 70). Refer to figure 11-8.

CAUTION

Take care when separating the case from the base that loose parts are not dropped and possibly damaged.

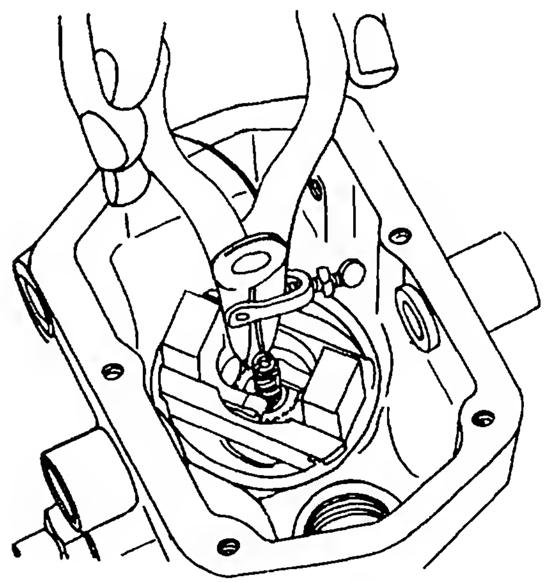


Figure 11-8. Removal of Governor Ballhead

(22) Unscrew three screws (72, figure 11-5), three washers (73), and carefully tap and pry the base (71) until dowel pins (81) holding the base to the case (96) are free. Separate base from case.

CAUTION

Take care not to damage any part of either the pilot valve bushing or the idler gear.

(23) Remove pilot valve bushing (74), idler gear (75), and idler gear stud (76).

(24) Remove directional plugs (77) and packings (78). Also remove check valve (79).

NOTE

Record position and orientation of items 77, 78, and 79 and duplicate during reassembly: how these items are reassembled determine the governor's direction of rotation (counterclockwise) as viewed from top of governor.

(25) Remove oil seal ring (80) and dowel pins (81).

(26) Unscrew and remove needle valve (84) and packing (85) from case (96).

(27) Remove relief valve assembly (87 through 91) from case (96).

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

b. Cleaning. Immerse all parts in solvent (P-D-680, Type II), and wash ultrasonically or by vigorous agitation. Very carefully, remove all traces of contaminents from corners, crevices, holes, and threads. Dry all parts with a lint-free cloth.

c. Inspection. To inspect the disassembled parts of the governor, proceed as follows:

(1) Check all parts for wear, corrosion, cracks, nicks, and burrs.

(2) Check threads for stripping or cross-threading.

(3) Check for mismatching of serrations or other gear tooth damage.

(4) Check idler gear and stud for wear in mating parts.

(5) Check power cylinder bushing for wear. If worn excessively, replace case. It is absolutely essential to governor operation that power piston moves freely in its cylinder.

(6) Check toes of flyweights for flat spots. Replace entire ballhead assembly if any of its parts appear to be defective.

(7) Check cover (63) for damage or bent surfaces. If damaged, replace entire ballhead assembly.

(8) Check all pivot pin holes and pivot pins for excessive wear.

(9) Check that pilot valve plunger has square edges on control lands.

(10) Check all bushings and bearings for wear.

(11) Check for lower race of thrust bearing (61) for wear pockets caused by flyweights.

(12) The buffer piston must slide freely in the buffer cylinder. Also check that the grooves around the buffer piston are clean. Grit and dirt in the system may "freeze" the buffer piston.

(13) With the governor at room temperature, inspect the power piston and ballhead bushings. A practical check for disallowable bushing shift is to draw a sharp lead pencil across the joint between the bushing and the case bottom (refer to figure 11-9). If a step is felt, the case should be discarded. In no instance can a case be used if bushing shift is greater than 0.0005 inch (0.0127 mm). The case may be reused if the shift is less than 0.0005 (0.0127 mm), but do not attempt to press the bushing back into position.

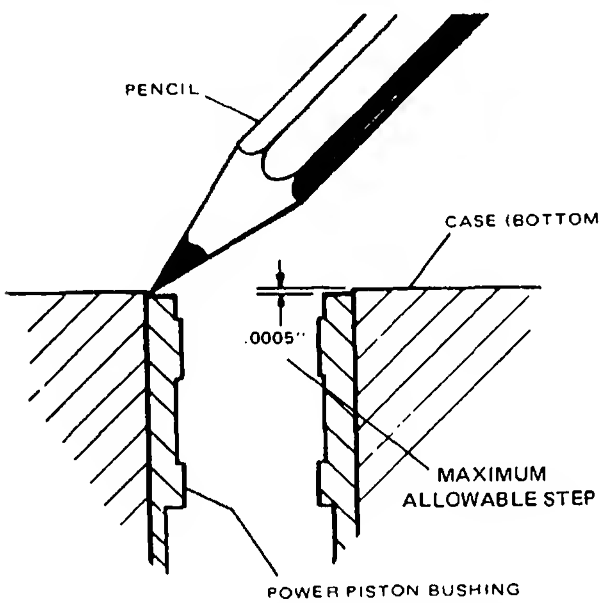


Figure 11-9. Governor Bushing Shift Check

d. Assembly. To assemble the governor, refer to figure 11-5 and proceed as follows:

NOTE

A complete overhaul should be performed if governor oil is very dirty or if it has been in service for a considerable period of time.

(1) If a complete overhaul is being performed replace the following parts:

(a) Packings and copper washers.

(b) Oil seals (25) on both terminal shafts (24).

(c) Spring wire pin (32).

(d) Thrust bearing (61).

(e) Directional plugs (77) if damaged or brittle.

(f) Ball check valves (79) as applicable.

(g) Idler gear (75) and stud (76) if wear is apparent, or if there is too much play in gear to stud mating.

CAUTION

Perform assembly in a dust-free environment and lightly oil all parts during assembly.

(2) Replace all plugs removed from the governor case and base and seal plugs with approved sealant (MIL-R-46082A).

CAUTION

Put sealant on plug threads and not in hole.

NOTE

If either the solid ballhead assembly tool (Special Tool T94312) or the ballhead spacer (Special Tool T94063) are not available, leave out pipe plug (83), in line with pilot valve bushing (74), on governor base until after the pilot valve plunger is assembled and adjusted.

(3) Seat new check valves on both base (71) and case (96) as shown in figure 11-10. Use check valve assembly tool (Special Tool T79679) for seating valves in base and check valve assembly tool (Special Tool T79516) for seating valves in case. (Both tools seat valves to correct depth.)

(4) If previously removed, place idler stud (76, figure 11-5) in position and seat it in base with idler stud intallation tool (Special Tool T79623).

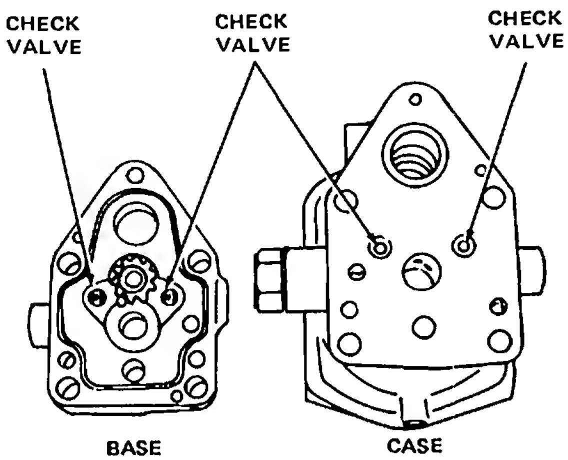


Figure 11-10. Governor Check Valve Assembly

(5) Place idler gear (75) on its stud and press a hard Arkansas stone on top of gear as shown in figure 11-11. Spin the gear using air pressure: this prevents the gear from binding between the case and the base.

(6) Hone sides of gear on pilot valve bushing (74) as shown in figure 11-12.

CAUTION

Do not damage surface of lands on valve.

(7) Insert directional plugs (77, figure 11-5) and packings (78) as shown in figure 11-13.

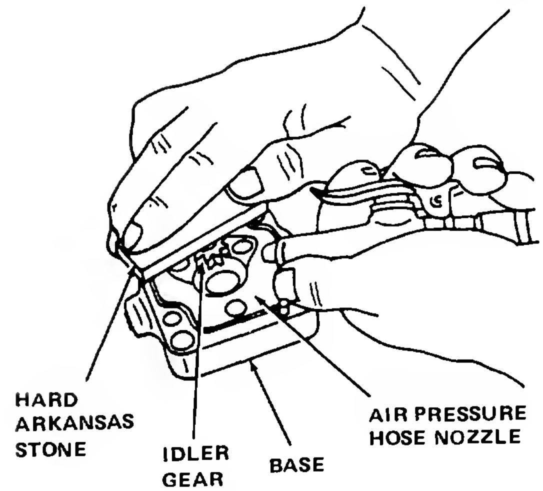


Figure 11-11. Honing Governor Idler Gear

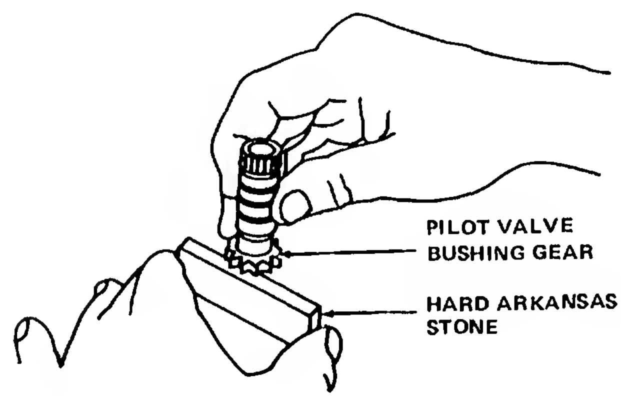


Figure 11-12. Honing Governor Pilot Valve Bushing Gear

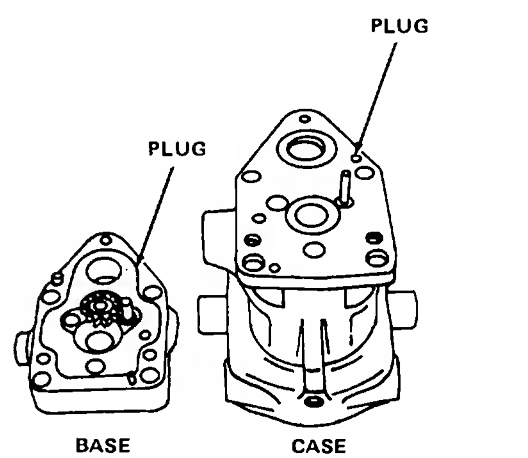


Figure 11-13. Plugs Inserted in Governor

(8) Assemble pilot valve plunger parts as shown in figures 11-14 and 11-15.

(9) Use retaining ring pliers, to fit retaining ring (60, figure 11-5) into top of pilot valve plunger (58).

(10) Complete seating retaining ring into inside groove with seating tool (Special Tool T79733): refer to figure 11-16.

(11) Assemble base (71) to case (96) with parts shown in figure 11-17. Insert pilot valve bushing (74, figure 11-5) in case and idler gear (75) in base.

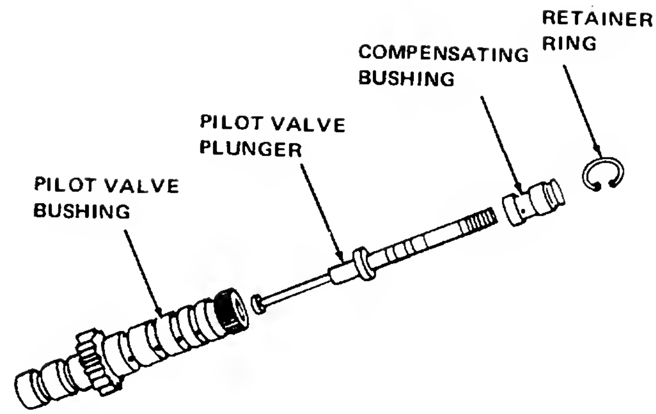


Figure 11-14. Governor Pilot Valve Bushing Assembly

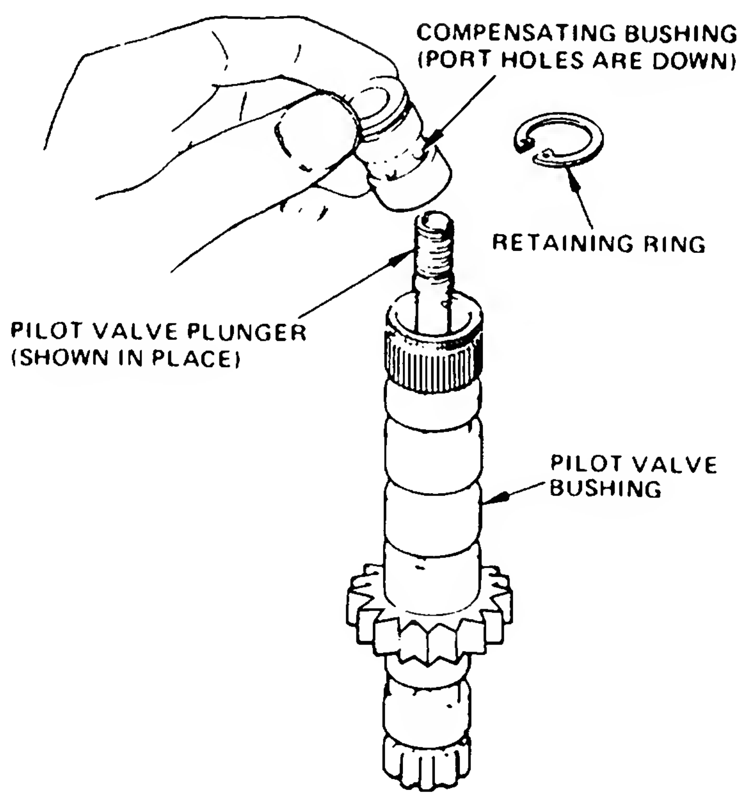


Figure 11-15. Governor Compensating Bushing Assembly

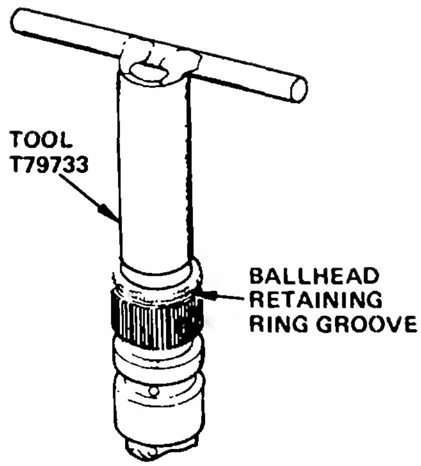


Figure 11-16. Governor Seating Retaining Ring

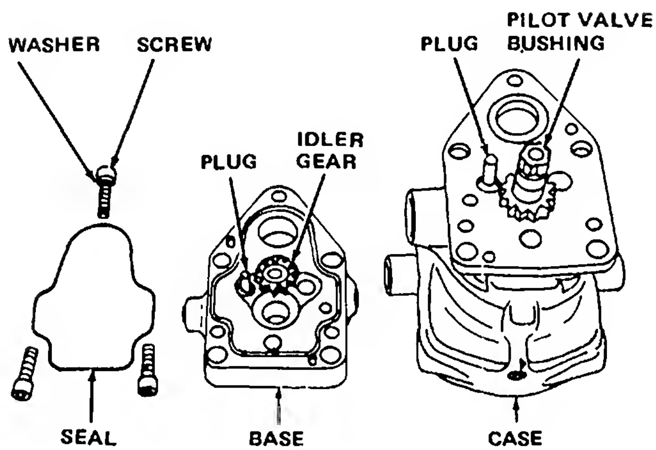


Figure 11-17. Governor Base to Case Assembly

(12) Place oil seal ring (80), flat wide side down, in groove provided in base.

(13) Secure base to case with three screws (72) and washers (73). Check that pilot valve bushing rotates freely.

NOTE

It may be necessary to loosen the base, free the gears, and then, to retighten the base.

NOTE

If alignment pins (81) are bent or damaged they shall be replaced.

(14) Assemble buffer system parts (50 through 54) into power piston (49) if required: refer to figure 11-18 and note position of holes in buffer piston: they must be in this position for proper operation.

(15) Place power piston assembly into case as shown in figure 11-19.

(16) Install power piston stop screw (45, figure 11-5) and bushing (46) into case and position as shown in figure 11-18. Secure parts with a new copper washer (48, figure 11-5) and elastic stop nut (47).

(17) Place ballhead assembly (63 through 70) on pilot valve bushing (59) and secure by placing retaining ring (62) into groove on outside of pilot valve bushing.

(18) Assemble thrust bearing (61), spring seat (56), nut (57), and speeder spring assembly (55). Refer to figure 11-20.

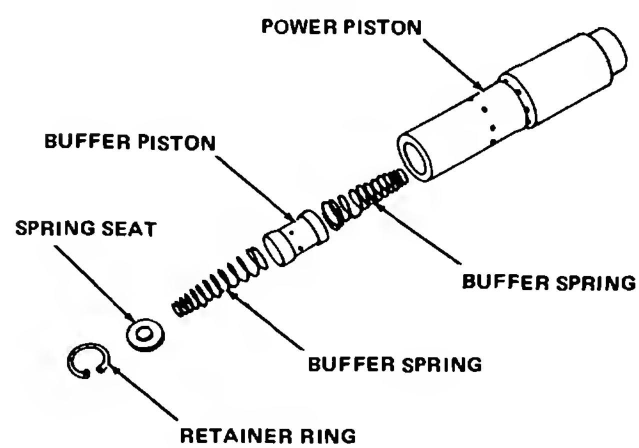


Figure 11-18. Governor Buffer System Assembly

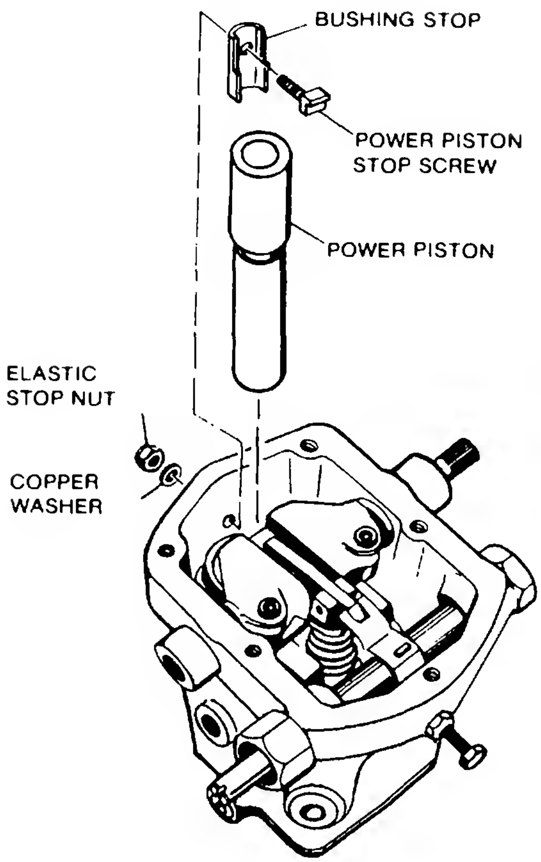


Figure 11-19. Governor Power Piston Assembly

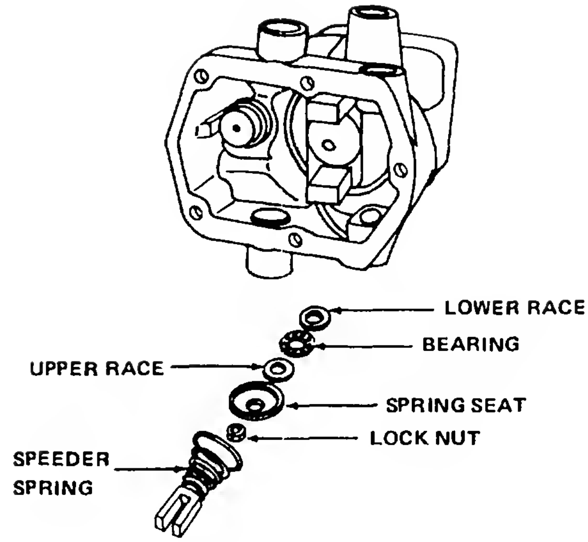


Figure 11-20. Governor Thrust Bearing and Speeder Spring Parts

NOTE

Place thrust bearing in position with open side down.

(19) Use a screwdriver (refer to figure 11-21) and guide spring seat (56, figure 11-5) and nut (57) onto pilot valve plunger (58). Hold the spring seat and nut and turn plunger counterclockwise threading seat (56) and nut (57) until nut is just below top of plunger (refer to figure 11-22).

(20) Release nut (57, figure 11-5) and continue turning plunger (58) until spring seat (56) is bottomed.

(21) Center pilot valve plunger (58) using tools shown in figure 11-23 and proceed as follows:

(a) Hold spring seat with pilot valve plunger wrench (Special Tool 370109) and set block (Special Tool T94063) between flyweights (69, figure 11-5).

(b) Press down on spring seat (56) with pilot valve plunger wrench: this forces flyweights inward to hold block (Special Tool T94063) suspended between the flyweights.

(c) Turn pilot valve plunger (58) with a screwdriver slowly until plunger contacts spacer (Special Tool T94312) and block just drops down on spring seat.

(d) Tighten nut (57) down onto spring seat (56) and torque to 70 pounds-inches (7.91 Newton-meters). Refer to figure 11-24.

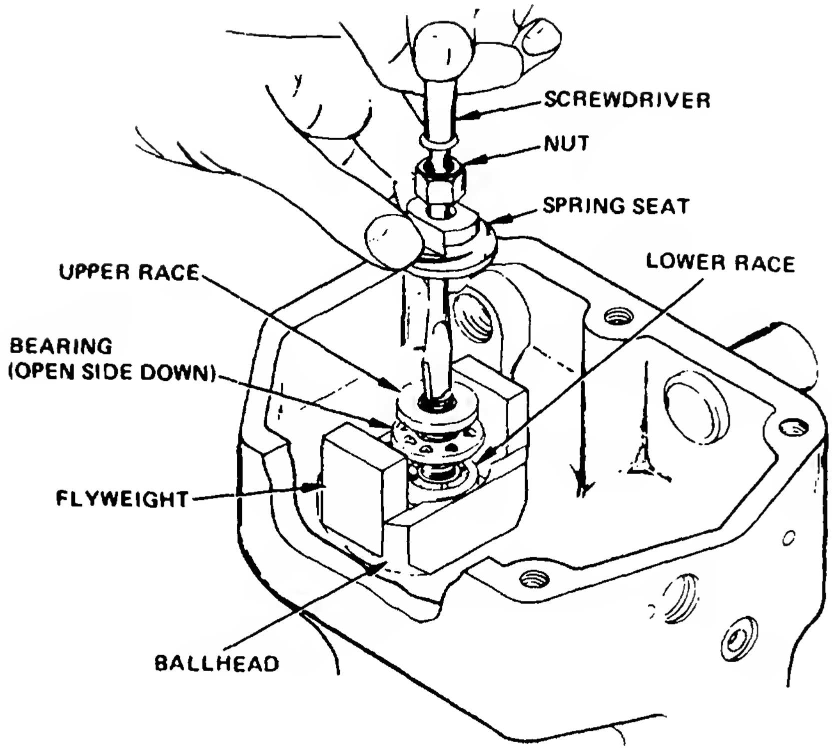


Figure 11-21. Governor Thrust Bearing and Spring Seat Assembly

NOTE

Steps (e) through (h) provide an alternate method of centering pilot valve plunger.

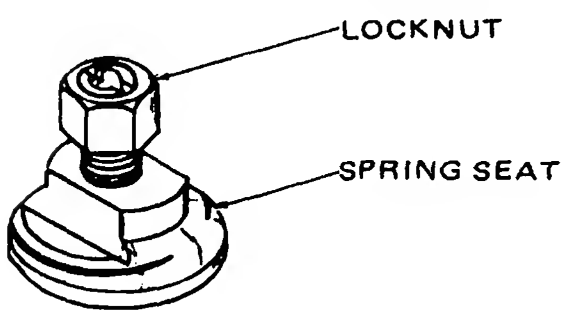


Figure 11-22. Governor Spring Seat Adjustment

(e) Check the centering of pilot valve plunger by removing plug and, looking through plug hole, observe the control port of pilot valve plunger as shown in figure 11-25.

(f) Push on the flyweight toes to lower the pilot valve plunger as far as possible. Check distance "A". Pivot flyweights out as far as possible and check distance "B". Distance "A" must equal distance "B" when flyweights have been moved from their extreme inward to their extreme outward position.

(g) If the pilot valve plunger is too low, use pilot valve wrench (Special Tool 370109) to hold spring seat stationary, and turn pilot valve plunger counterclockwise to raise it. If the pilot valve plunger is too

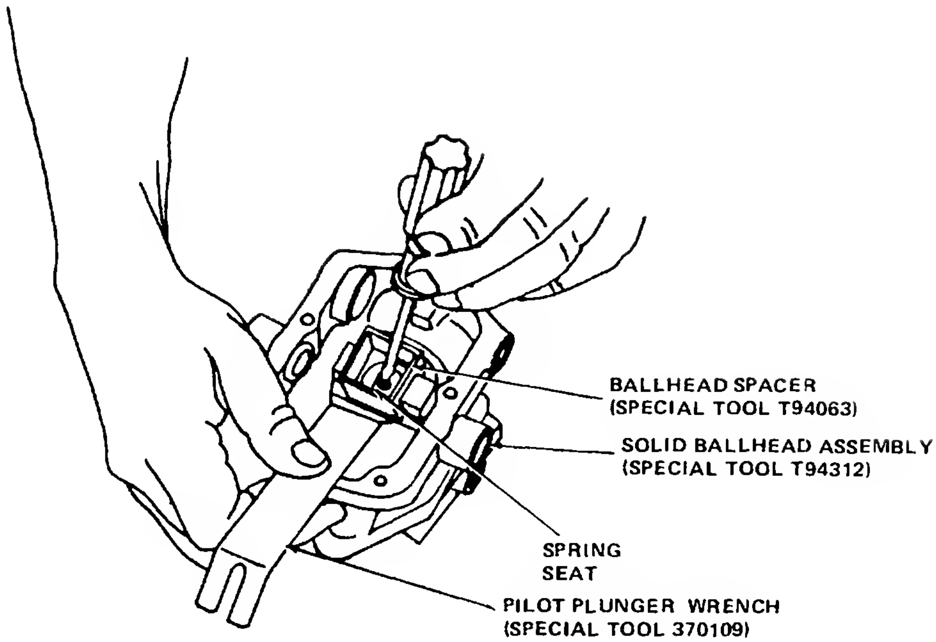


Figure 11-23. Centering the Governor Pilot Valve Plunger

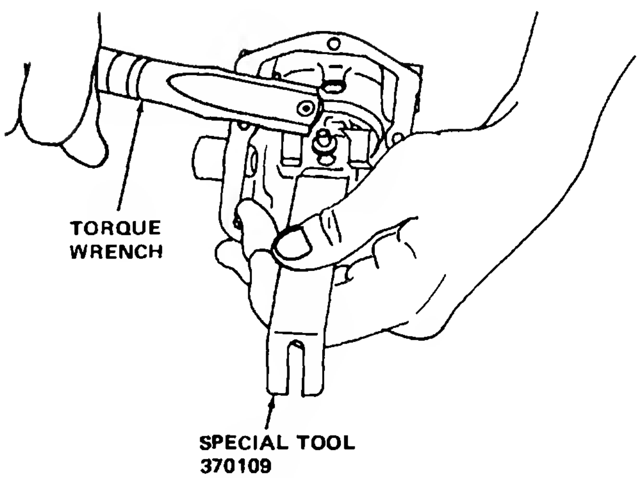


Figure 11-24. Torquing Governor Locknut

high, hold spring seat and turn pilot valve plunger clockwise to lower it.

(h) When pilot valve plunger is centered, tighten nut (57, figure 11-5) as shown in figure 11-24 by torquing it to 70 pound-inches (7.91 Newton-meters).

(22) Install speeder spring (55, figure 11-5) on spring seat (56). Place pilot valve plunger wrench (Special Tool T370109) under spring seat and force spring seat upwards and, at the same time, place speeder spring on top of spring seat. Hold spring seat and push spring down and turn clockwise to secure it to spring seat (refer to figure 11-26).

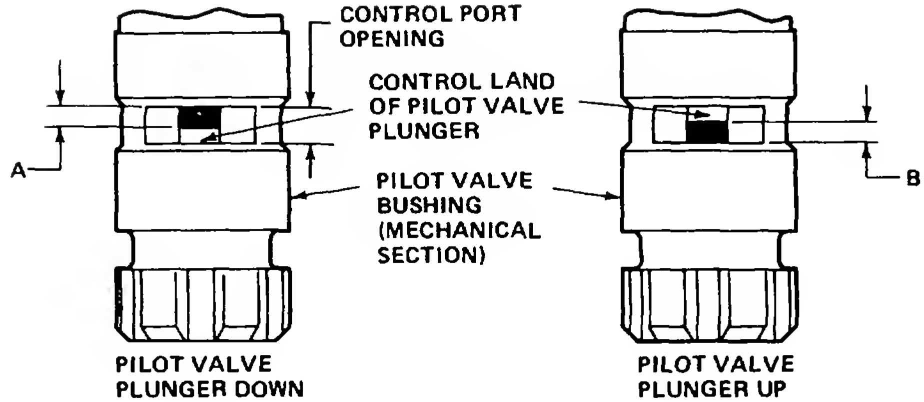


Figure 11-25. Centering Governor Pilot Valve Plunger

(23) Install terminal lever (21, figure 11-5) and secure in position with terminal shafts (24).

(24) Install two screws and washers (22, 23) and lock terminal lever (21) onto ends of terminal shafts (24).

(25) Place spring seat (26) over power piston strut (28) and secure with nut (27).

(26) Insert pivot pin (29) through appropriate hole in terminal lever (21) and place power piston strut (28) through hole in pivot pin (29); lower piston strut into power piston (49).

(27) Screw droop adjust sleeve assembly (38) and replacement copper washer (39) into side of case (96).

(28) Assemble speed droop parts (40 through 43) and insert into droop adjust sleeve assembly (38). Make certain that sliding blocks at end of droop link (40) are inserted into channels of terminal lever (21).

(29) Screw speed adjust sleeve assembly (30) and replacement copper washer (31) into side of case (96).

(30) Insert speed adjust shaft (37) into speed adjust lever (34) so that cotter pin hole in shaft lines up with similar hole in lever.

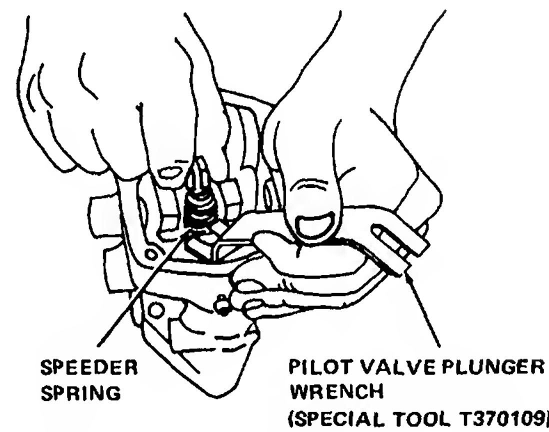


Figure 26. Governor Speeder Spring Installation

(31) Tap cotter pin (35) through lever (34) and shaft (37).

(32) Place torsion spring (36) over shaft (37). Make certain end of spring rests in hole at side of lever (34).

(33) Place speed assembly (34 through 37) into speed adjust assembly (30).

(34) Tighten sleeves (30 and 38) a torque of 30 foot-pounds (40.67 Newton-meters).

(35) Position floating lever (33) in speed adjust lever (34). Refer to figure 11-27.

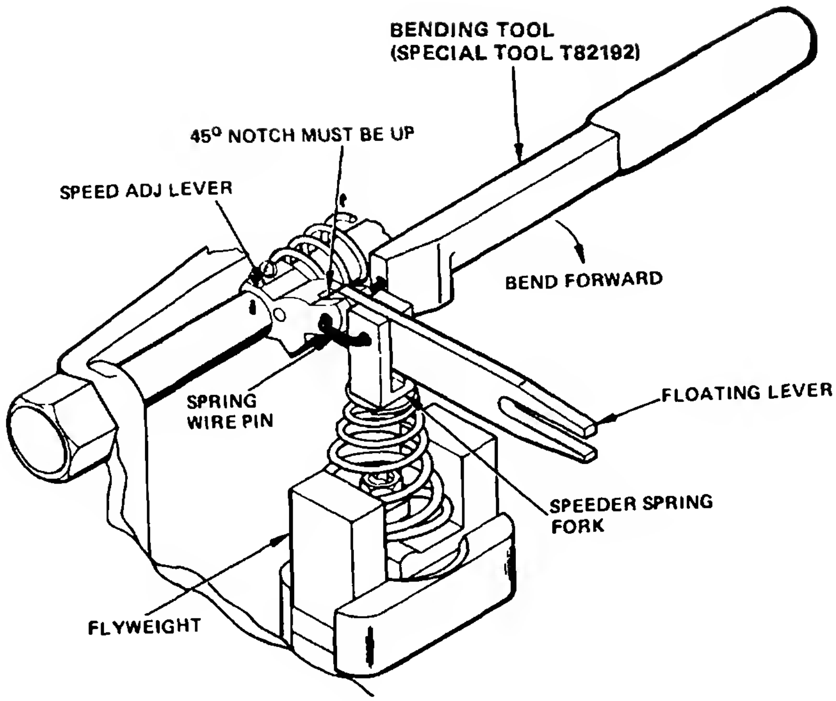


Figure 11-27. Governor Speed Adjusting and Floating Lever Assembly

NOTE

Make certain slot of floating lever straddles pin at end of droop link assembly (40) and that 45 degree notch of floating lever is on top.

(36) Align holes in floating lever (33, figure 11-5), speed adjust lever (34), and speeder spring fork (55) and secure together with U-shaped pin (32).

(37) Bend pin (32) with bending tool (Special Tool T82192) as shown in figures 11-27 and 11-28.

(38) Place seal installation tool (Special Tool T94157) on terminal shaft (24, figure 11-5) and slide seals (25) onto tool with cups of seals facing each other. Press seals (25) into bushing (44) with seal installation tool until seated (refer to figure 11-29).

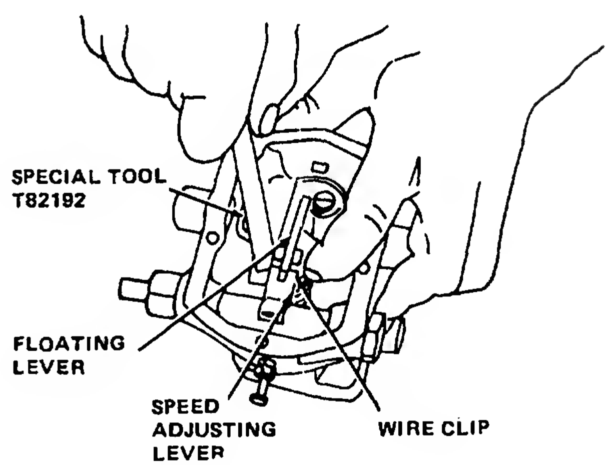


Figure 11-28. Bending Governor Spring Wire Pin

(39) Repeat step (38) for other terminal shaft (24, figure 11-5).

(40) Install relief valve assembly (87 through 91) into case (96) and tighten.

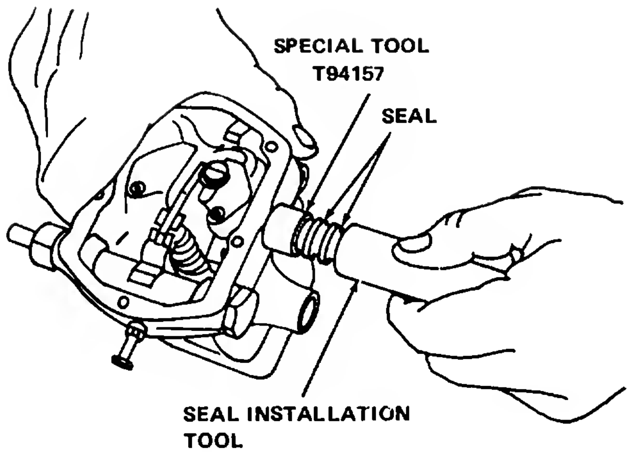


Figure 11-29. Governor Seal Installation

(41) Align holes of gasket (20) with holes of case (96) and place sub cap (11) over gasket; secure sub cap in place with screws and washers (12 and 13).

(42) Align holes of gasket (10) with holes of sub cap (11).

(43) Place vertical return spring (9) in place over spring seat (26).

(44) Force cover (1) over sub cap and gasket (11 and 10) against compression of spring (9); secure in place with screws and washers (2 and 3).

(45) Install external speed droop adjustment parts (14 through 19 and 99 through 101).

Section III. MAINTENANCE OF EXHAUST MANIFOLD

11-7. GENERAL. The exhaust manifold is mounted on the right side of the cylinder head. The manifold assembly consists of a heat shield, forward and rear manifolds, gaskets, and mounting hardware. Exhaust gases from the cylinders are routed through the manifold and into the turbocharger.

11-8. REPAIR.

a. Refer to the Operator and Organizational Maintenance Manual and remove exhaust manifold.

b. Remove minor nicks and burrs from manifold mating surfaces using a file or hone (see figure 11-30).

c. Repair minor thread damage using a thread chaser.

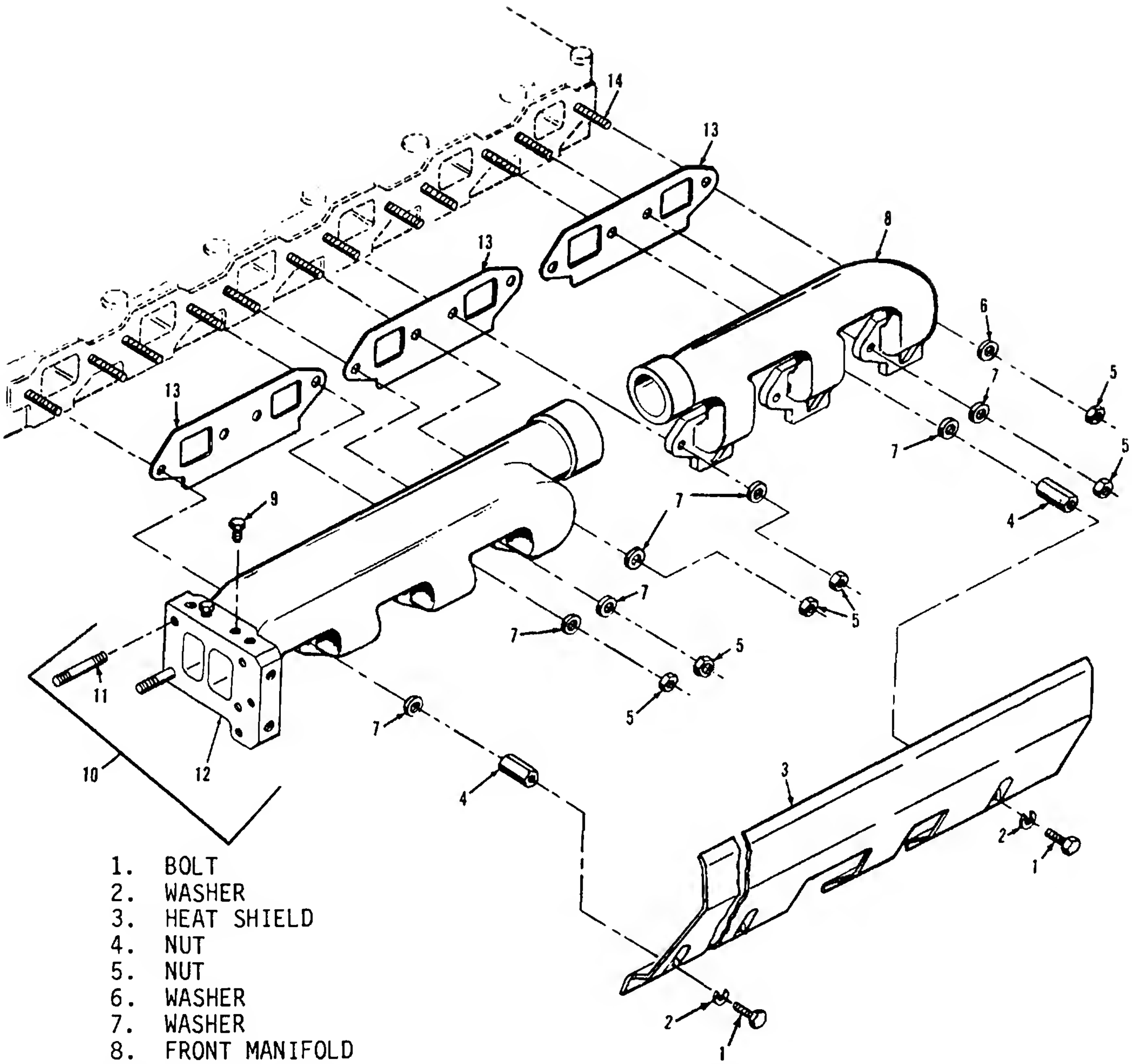
d. Remove any traces of old exhaust manifold gaskets.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

e. Use cleaning solvent, P-D-680, Type II, and a stiff brush to remove all excess rust and carbon deposits from manifold and manifold hardware. Place hardware in a container of lightweight oil and allow to soak until needed for reassembly.

f. Refer to Operator and Organizational Maintenance Manual and install exhaust manifold.



1. BOLT
2. WASHER
3. HEAT SHIELD
4. NUT
5. NUT
6. WASHER
7. WASHER
8. FRONT MANIFOLD
9. PLUG
10. REAR MANIFOLD ASSY
11. STUD
12. REAR MANIFOLD
13. GASKET
14. MOUNTING STUD

Figure 11-30. Exhaust Manifold, Exploded View

Section IV. MAINTENANCE OF CYLINDER HEAD ASSEMBLY GROUP

11-9. GENERAL. The cylinder head assembly group is mounted on top of the cylinder block. The cylinder head assembly group consists of the valve mechanism, valves, valve springs and guides, the cylinder head assembly, spacer plate, and lifting eyes. Cored passages in the cylinder head direct the flow of coolant around the valve ports and precombustion chambers. Air intake passages route compressed air from the turbocharger to the air inlets of each cylinder. Oil passages allow lubricant to be distributed to the valve mechanism. The valve mechanism consists of inlet and exhaust rocker arm assemblies, push rods, and lifters. Two arm assemblies are provided for each cylinder, one operating the exhaust valve and one operating the inlet valve. The arm assemblies are actuated by the camshaft through lifters and pushrods.

11-10. REMOVAL AND DISASSEMBLY OF CYLINDER HEAD ASSEMBLY GROUP.

WARNING

Disconnect negative battery cable before performing this engine maintenance procedure.

a. Remove valve cover (with exhaust breather attached) in accordance with the Operator and Organizational Maintenance Manual. Remove and discard valve cover gasket.

b. Remove the valve mechanism as follows (see figure 11-31).

(1) Loosen adjusting screws (13 and 18) on exhaust and inlet rocker arm assemblies (11 and 16).

(2) Remove bolts (1) and washers (2) and remove valve mechanism assembly (3) from the cylinder head.

c. Remove pushrods (4) from cylinder head.

NOTE

Cylinders are numbered consecutively from front to rear. Exhaust valves are first valves at each cylinder as viewed from front of engine.

d. If necessary, disassemble valve mechanism assembly as follows:

(1) Remove and discard seal ring (6) from rear support bracket (22).

(2) Remove retaining rings (7), washers (8), springs (9), and washers (10) from each end of shaft (30).

(3) Remove rear (number six cylinder) inlet rocker arm assembly (16).

(4) Remove front (number one cylinder) inlet rocker arm assembly (16).

(5) Remove nuts (12 and 17), and adjusting screws (13 and 18) from rocker arm assemblies only if damaged, worn, or defective.

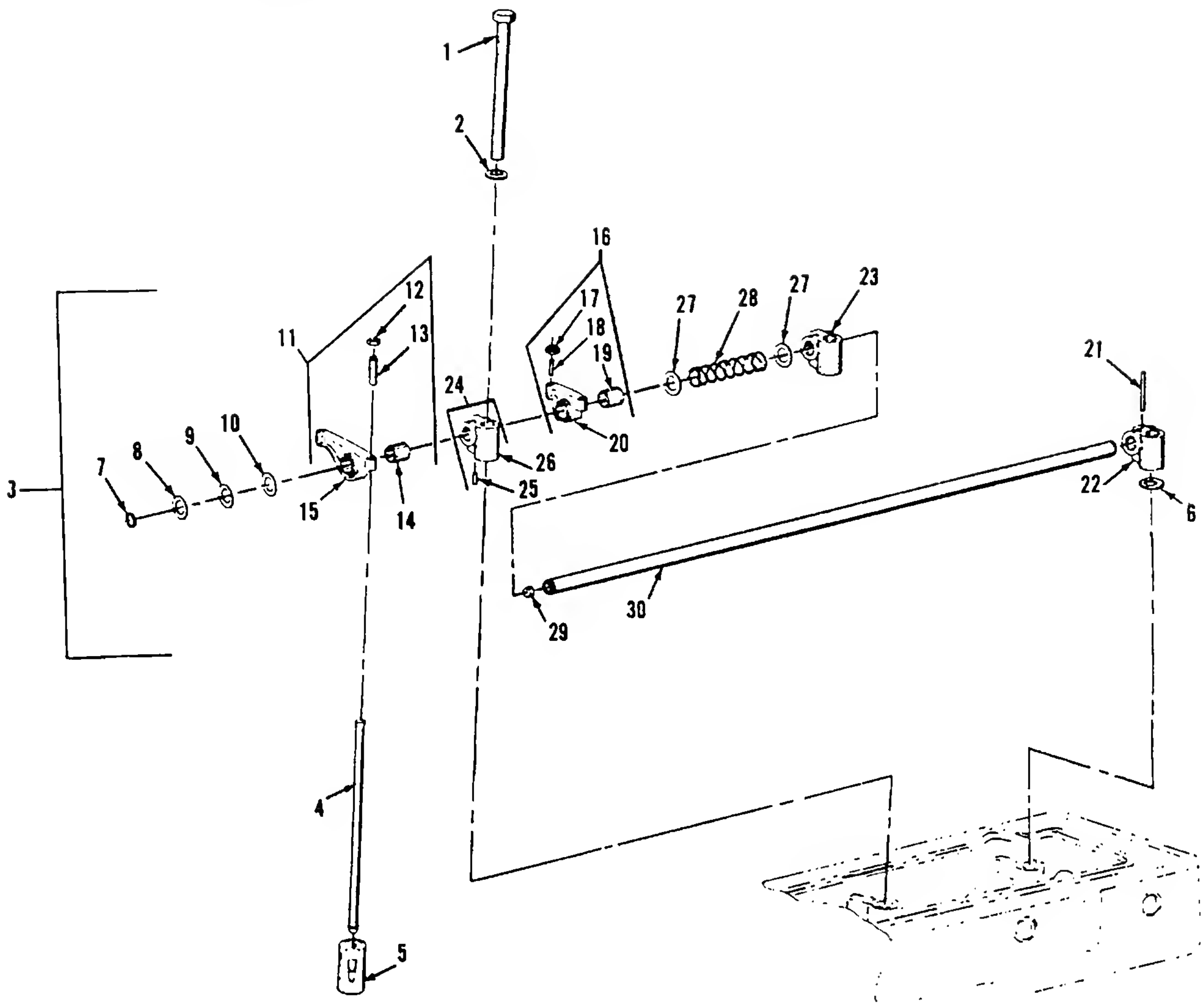
(6) Use a driver to remove bearings (14 and 19) from rocker arms (15 and 20) only if damaged, worn, or defective.

(7) Remove the pin (21) from the rear support bracket (22) using a hammer and punch. Remove rear support bracket (22) from shaft (30).

(8) Remove remaining rocker arm assemblies (11 and 16), brackets (23 and 24), washers (27), and springs (28). Disassemble rocker arm assemblies (11 and 16) only if damaged, worn, or defective. Remove dowel (25) from front bracket assembly (24) only if damaged, worn, or defective.

(9) Remove plugs (29) from each end of shaft (30) if damaged, worn, or defective.

e. Remove cylinder head assembly as follows (see figure 11-32).



1. BOLT
2. WASHER
3. VALVE MECHANISM ASSY
4. PUSHRODS
5. LIFTER
6. SEAL RING
7. RETAINING RING
8. WASHER
9. SPRING
10. WASHER
11. EXHAUST ROCKER ARM ASSY
12. NUT
13. ADJUSTING SCREW
14. BEARING
15. ARM
16. INLET ROCKER ARM ASSY
17. NUT
18. ADJUSTING SCREW
19. BEARING
20. ARM
21. PIN
22. REAR SUPPORT BRACKET
23. BRACKET
24. FRONT BRACKET ASSY
25. DOWEL
26. FRONT BRACKET
27. WASHER
28. SPRING
29. PLUG
30. SHAFT

Figure 11-31. Valve Mechanism, Exploded View

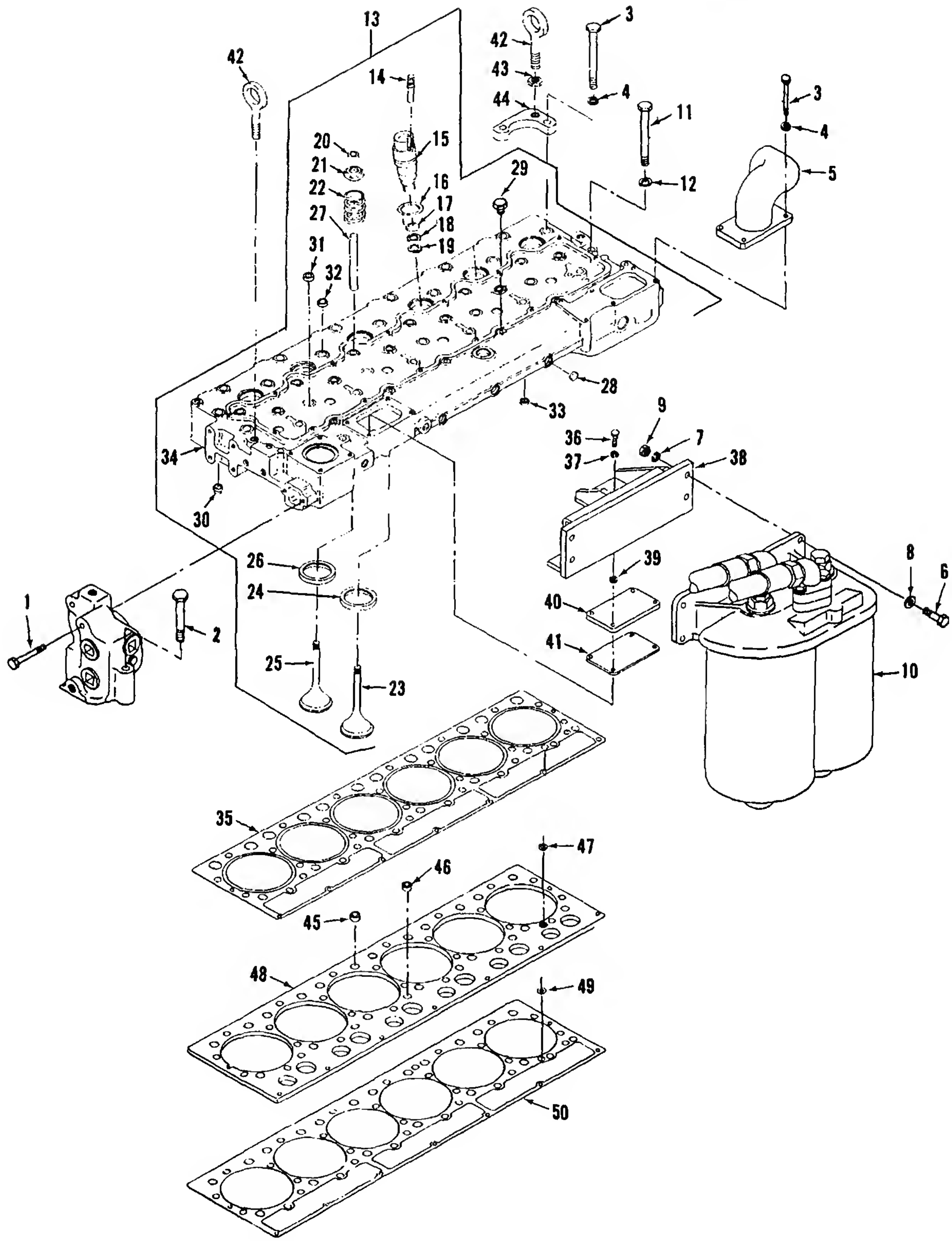


Figure 11-32. Cylinder Head Assembly, Exploded View (Sheet 1 of 2)

1. BOLT	26. INSERT
2. BOLT	27. VALVE GUIDE
3. BOLT	28. PLUG
4. WASHER	29. BOLT
5. AIR INLET ELBOW	30. DIRECTOR
6. BOLT	31. SEAL
7. LOCKWASHER	32. SEAL
8. WASHER	33. SEAL
9. NUT	34. CYLINDER HEAD
10. OIL FILTER ASSY	35. GASKET
11. BOLT	36. BOLT
12. WASHER	37. LOCKWASHER
13. CYLINDER HEAD SUBASSY	38. OIL FILTER SUPPORT ASSY
14. PLUG	39. WASHER
15. PRECOMBUSTION CHAMBER	40. COVER
16. SEAL	41. GASKET
17. GASKET	42. LIFTING EYE
18. GASKET	43. NUT
19. GASKET	44. PLATE
20. LOCK	45. LARGE WATER FERRULES
21. ROTOCOIL ASSY	46. SMALL WATER FERRULES
22. VALVE SPRING	47. SEAL RING
23. EXHAUST VALVE	48. SPACER PLATE
24. INSERT	49. SEAL RING
25. INLET VALVE	50. GASKET

Figure 11-32. Cylinder Head Assembly, Exploded View (Sheet 2 of 2)

(1) Refer to the Operator and Organizational Maintenance Manual to drain cooling system, remove housing as necessary for access, remove ether and fuel injection lines, turbocharger, exhaust manifold, coolant thermostat, and fuel injection valves.

(2) Remove bolts (1) from top of the water pump. Loosen bolts (2) in the water pump face.

(3) Remove bolts (3) and washers (4) which secure compressed air (from turbocharger) inlet elbow (5) to cylinder head. Remove elbow (5). Remove remaining bolts (3) and washers (4).

(4) Remove bolts (6), lockwashers (7), washers (8), and nut (9) to remove oil filter assembly (10) from the oil filer support assembly (38).

(5) Remove cylinder head bolts (29).

(6) Remove cylinder head bolts (11) and washers (12) which secure the cylinder head (34) to the cylinder block.

CAUTION

Weight of cylinder head is 290 pounds (131 kg). Do not put cylinder head down on a flat surface. This may cause damage to the valves.

(7) Fasten an overhead hoist (capable of lifting 1/ 2-ton (454 kg) minimum) to the lifting eyes and remove cylinder head subassembly (13) from the cylinder block.

(8) Using a wrench, remove precombustion chamber assemblies (15) from cylinder head (34) as required. Keep associated plug (14) with each chamber.

(9) Remove and discard seals (16) and gaskets (17, 18, and 19).

(10) Use a spring compressor to remove locks (20) to rotocoil assemblies (21) and valve springs (22). Remove valves (23 and 25).

NOTE

Do not remove inserts (24 and 26) unless repair or replacement is required.

(11) If necessary, remove inserts (24 and 26) using an extracting tool.

(12) Remove valve guides (27) from cylinder head (34).

(13) Remove plugs (28), water directors (30), and seals (31, 32, and 33) from cylinder head (34). Discard directors and seals.

(14) Remove and discard gasket (35).

(15) Remove bolts (36) and lockwashers (37) to remove oil filter support assembly (38), washers (39), cover (40), and gasket (41) from cylinder head (34).

(16) If necessary, place cylinder head on a suitable surface and remove lifting eyes (42), nut (43), and plate (44).

(17) Remove and discard large and small water ferrules (45 and 46) from spacer plate.

(18) Remove and discard seal ring (47).

(19) Remove spacer plate (48).

(20) Remove and discard seal ring (49) and spacer plate gasket (50).

11-11. INSPECTION. Use a micrometer and pilot gages to check for worn components. Refer to table 1-3 for acceptable diameter and wear limits. Replace worn or damaged components.

a. Check rocker arm bearings (14 and 19, figure 11-31) bore.

b. Check shaft (30) diameter.

c. Check clearance between bearings (14 and 19) and shaft (30).

d. Inspect ball end of adjusting screws (13 and 18) and valve contact surface of rocker arm assemblies (11 and 16) for nicks, discoloration, and uneven wear spots.

e. Inspect rocker arm brackets (22, 23, and 24) and shaft (30) to ensure that oil passages are open.

f. Check pushrod (4) for straightness. Do not attempt to straighten pushrods.

g. Inspect precombustion chambers (15, figure 11-32) for cracks, damaged threads, or distortion. Check tightness of associated plug (14) with its precombustion chamber (15).

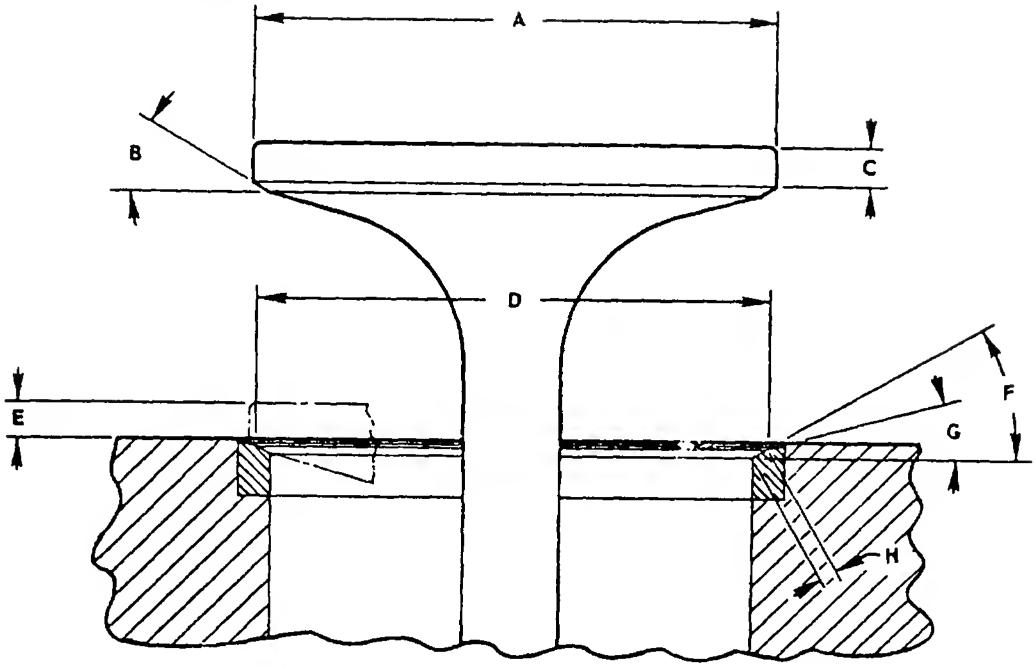
h. Inspect valve springs (22) for damaged coils, cracks, bending, or distortion.

i. Inspect valve guides (27) for cracks, distortion, or excessive wear. Check inside diameter of valve guides.

j. Coat each valve face with a thin film of Prussian blue, then rotate each valve in associated valve seat. Remove valves and examine contact pattern on each valve and valve seat. A line of contact near top and around entire circumference of valve seat indicates line contact with valve. This amount of line contact indicates that the valves and valve seats are acceptable. If, however, line contact is not noted to extend completely around the seat, or gaps in line contact appear around the seat, this indicates that the valves have to be reground.

k. Inspect valves (23 and 25) and valve seat inserts (24 and 26) for cracks, pitting, distortion, or excessive wear. Refer to figure 11-33 and check for valve head diameter, valve face angle, valve lip thickness, valve lip thickness, valve seat diameter, valve projection, and valve seat angle.

l. Inspect cylinder head (34, figure 11-32) for cracks, pitting, damaged threads, distortion, or defects. Use a magnetic crack detector to locate



VALVE AND VALVE SEAT SPECIFICATIONS

A - VALVE HEAD DIAMETER. B - VALVE FACE ANGLE. C - MINIMUM VALVE LIP THICKNESS. D - OUTSIDE DIAMETER OF VALVE SEAT FACE. E - CLOSED VALVE PROJECTION. F - VALVE SEAT FACE ANGLE. G - ANGLE TO GRIND INSERT SEAT FACE TO REDUCE MAXIMUM SEAT DIAMETER. H - MAXIMUM PERMISSIBLE VALVE SEAT WIDTH.

	INLET	EXHAUST
A	2.020 ±0.005 inch (51.31 ± 0.13 mm)	1.896 ±0.005 inch (48.16 ±0.13 mm)
B	29-1/4 degrees	29-1/4 degrees
C	0.106 inch (2.69 mm)	0.106 inch (2.69 mm)
D	1.959 ±0.025 inch (49.76 ±0.64 mm)	1.835 ±0.025 inch (46.61 ±0.64 mm)
E	0.103 ±0.037 inch (2.62 ±0.94 mm)	0.098 ±0.42 inch (2.49 ±1.07 mm)
F	30 degrees	30 degrees
G	15 degrees	15 degrees
H	0.0605 ±0.0155 inch (1.54 ± 0.395 mm)	0.0605 ±0.0155 inch (1.54 ±0.395 mm)

Figure 11-33. Valve and Valve Seat Measurement Points

cracks in the cylinder head. Check the bottom face of the cylinder head for warpage. Do not attempt to patch or weld any cracks in the cylinder head.

m. Check spacer plate (48) for cracks, pitting, warpage, damage, or distortion. Use a magnetic crack detector to locate cracks in the spacer plate.

11-12. TEST.

a. Pressure test the cylinder head as follows:

(1) Seal off all openings in the cylinder head with plugs or steel plates and rubber gaskets secured with bolts and washers. Drill and tap one of the cover plates for an air hose connection.

(2) Preheat a tank of water to 180° to 200°F (82 to 93°C).

(3) Apply 45 psi (310 kPa) air pressure to the head.

(4) Immerse cylinder head in water and let stand about 20 minutes to thoroughly heat the head. Observe the water in the tank for bubbles which indicate a leak or crack.

(5) Relieve air pressure and remove the cylinder head from water tank. Remove plates and gaskets and dry the head with compressed air.

b. If the pressure test revealed any cracks, replace the cylinder head. Do not attempt to patch or weld cracks in the cylinder head.

c. Test valve spring (22) force. Compress each spring to a length of 1.766 inches (44.86 mm). Force required for compression should be 57.7 +/-2.9 pounds (26.2 +/-1.3 kg). The minimum force required for reuse of valve spring is 52 pounds (23.6 kg).

11-13. REPAIR.

CAUTION

Do not remove any more material than is required to remove discoloration and small nicks.

NOTE

The contact surfaces on adjustment screw (13 and 18, figure 11-31) and lifter end of pushrod (4) may be noted to have a flat surface on the ball end. This flat surface is allowed by the manufacturer during production and is not to be considered a worn part. The adjusting screw ball end is allowed a 0.19 inch (4.83 mm) diameter flat, and the lifter end of the pushrod is allowed a 0.125 inch (3.18 mm) diameter flat.

a. Clean up contact surfaces on adjusting screws (13 and 18) and rocker arm assemblies (11 and 16) using a hone.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

b. Clean out oil passages in rocker arm brackets (22, 23, and 24) and shaft (30) using a thin wire. Flush with cleaning solvent, P-D-680, Type II.

c. Repair valves which do not seat properly (refer to paragraph 11-11, above) by grinding valves or valve seat inserts using a suitable grinder. After grinding, recheck valves or valve inserts according to paragraph 11-11.

d. Repair loose valve seat inserts by enlarging the counterbore. The insert counterbore must be enlarged sufficiently to accept the next standard oversize insert. After enlarging counterbore, install insert in accordance with paragraph 11-14.

11-14. OVERHAUL AND REBUILD.

a. Resurface cylinder head if it is scratched, etched, or worn unevenly. Use an orbital sander to sand cylinder head. Do not remove more than 0.020 inches (0.508 mm) metal in total from

bottom face of cylinder head. The minimum resuable thickness of the cylinder head is 3.888 inches (98.755 mm). Stamp the amount of stock removed on the bottom face in an area not used as a sealing surface.

CAUTION

When a cylinder head has been resurfaced, critical dimensions such as valve seat inserts, valves, and precombustion chambers must be checked and corrected. The push rods must also be adjusted to prevent valves from striking the piston after the cylinder head assembly is reinstalled.

b. Install new valve seat inserts (24 and 26, figure 11-32) or oversize valve seat inserts if counterbore was enlarged, as follows:

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

(1) Clean cylinder head with solvent (P-D-680, Type II) and dry thoroughly.

(2) Clean and remove burrs from valve seat bore.

(3) Rest the cylinder head upside down on a bench, and lay a new insert in counterbore, valve seat up. This must be done quickly while the cylinder head is hot and the insert is cold (room temperature).

(4) Using a valve seat insert installation tool, drive insert down tight into counterbore.

(5) Grind the new valve seat insert to the tolerances in figure 11-33.

c. Rebuild cylinder head assembly by replacing all worn or damaged parts, all seals and gaskets, large and small water ferrules (45 and 46, figure 11-32), water directors (30), adjusting screws (13 and 18, figure 11-31), all springs, valves, valve guides, and inserts.

11-15. REASSEMBLY AND INSTALLATION OF CYLINDER HEAD ASSEMBLY GROUP.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

a. Clean cylinder block surface and spacer plate with solvent, P-D-680, Type II, and dry thoroughly.

CAUTION

Both surfaces of spacer plate, top of cylinder block and both sides of spacer plate gasket must be clean and dry. Do not use any gasket adhesives or other substances on these surfaces.

b. Install new spacer plate gasket (50, figure 11-32) new ring seal (49), and spacer plate (48).

c. If new valve seat inserts (24 and 26) are to be installed, refer to paragraph 11-14.

d. Install new large (45) and small (46) water ferrules and new seal ring (47).

e. Check cylinder liner projection in accordance with paragraph 11-31.

f. If removed during disassembly, install plate (44), nut (43), and lifting eyes (42).

g. Install new gasket (41), cover (40), and oil filter support assembly (38) using washers (39), lockwashers (37), and bolts (36).

h. Assemble cylinder head assembly as follows:

(1) Install new seals (31, 32, and 33) and plugs (28 and 29) into cylinder head (34).

(2) Install new water directors (30) with opening in director aligned with "V" mark stamped on head.

(3) Lubricate valve guide (27) with the engine oil. Using a valve guide driver, install valve guides (27) into cylinder head (34). Valve guide projection above the cylinder must not exceed 0.875 inch (22.23 mm).

(4) If valve seat inserts (24 and 26) were removed for grinding, reinstall.

WARNING

Locks (20) can be thrown from valve when spring compressor is released. Be sure locks are secure before releasing compressor.

(5) Lubricate valve stems with engine oil. Position valve (23 or 25), valve spring (22), and rotocoil assembly (21). Using a spring compressor, compress valve spring and install lock (20).

(6) Coat new seal (16) and threads of precombustion chambers (15) with anti-seize compound, MIL-C-47167. Select and install one of the new gaskets (17, 18, or 19), seal (16), and precombustion chamber (15). Torque chamber to 150 +/-50 foot-pounds (203 +/-20 Newton-meters).

(7) Coat the threads of plug (14) with anti-seize compound, MIL-C-47167, and install plug. Torque the plug to 120 +/-24 inch-pounds (14 +/-3 Newton-meters). Use wrench, pre-combustion, P/N 5F8353, NSN 5120-00-157-0718

CAUTION

The top surface of the spacer plate, bottom of the cylinder head, and both surfaces of the head gasket (35) must be clean and dry. Do not use any gasket adhesives or other substances on the surfaces.

i. Install new head gasket (35). Install cylinder head subassembly (13) and rock head gently until is is flat on the head gasket (35).

j. Assemble the valve mechanism as follows (see figure 11-31):

(1) If rocker arm assemblies (11 or 16) were broken down during disassembly, then use install bearing (14 or 19). Install adjusting screws (13 or 18) with nuts (12 and 17).

NOTE

Rear support bracket (22) and rear (cylinder number six) exhaust rocker arm assembly are not installed at this point.

(2) Install spring (28), washers (27), brackets (23 and 24), and rocker arm assemblies (11 and 16) onto shaft (30).

(3) Install rear support bracket (22) on rocker shaft (30). Make sure hole in bracket (22) is in alignment with hole in shaft (30).

(4) Install pin (21) into bracket using a hammer. Pin (21) must extend 0.378 inches (9.60 mm) above the bracket.

(5) Install seal ring (6) into bracket (22).

(6) Install rear (cylinder number six) exhaust rocker arm assembly.

(7) Install washers (10), springs (9), washers (8), and retaining ring (7) onto shaft (30).

k. Install pushrods (4).

l. Position valve mechanism assembly (3) on cylinder head assembly.

m. If the valve mechanism was removed from the cylinder head, but the cylinder head was not removed from the block, see figure 11-34 View A and torque the valve mechanism bolts (1, figure 11-31) as follows:

(1) Coat threads of all bolts with anti-seize compound, MIL-C-47167.

(2) Torque bolts in numbered sequence to 175 +/-5 foot-pounds (236 +/-6.8 Newton-meters) and check torque

of cylinder head bolts (3 and 11, figure 11-32).

n. If the cylinder head was removed from the block, proceed as follows:

NOTE

Lifting eye (42) and plate (44) must be installed before cylinder head can be torqued down (refer to step f, above).

(1) Coat threads of valve mechanism bolts (1, figure 11-31) and cylinder head bolts (3, 11, and 29, figure 11-32) with anti-seize compound, MIL-C-47167.

(2) Position compressed air inlet elbow (5).

(3) Tighten all bolts in number sequence to a torque of 115 foot-pounds (155 Newton-meters) (refer to figure 11-34 and table 1-2).

(4) Again tighten all bolts in number sequence to a torque of 175 +/-5 foot-pounds (236 +/-6.8 Newton-meters).

(5) Verify all bolts in number sequence (hand torque only) to a torque of 175 +/-5 foot-pounds (236 +/-6.8 Newton-meters).

(6) Tighten all bolts in letter sequence to a torque of 22 foot-pounds (30 Newton-meters).

(7) Again tighten all bolts in letter sequence to a torque of 32 +/-5 foot-pounds (43 +/-7 Newton-meters).

(8) Verify all bolts in letter sequence to a torque of 32 +/-5 foot-pounds (43 +/-7 Newton-meters).

o. Secure the oil filter assembly (10) to the oil filter support assembly (38) using bolt (6), lockwasher (7), washer (8), and nut (9).

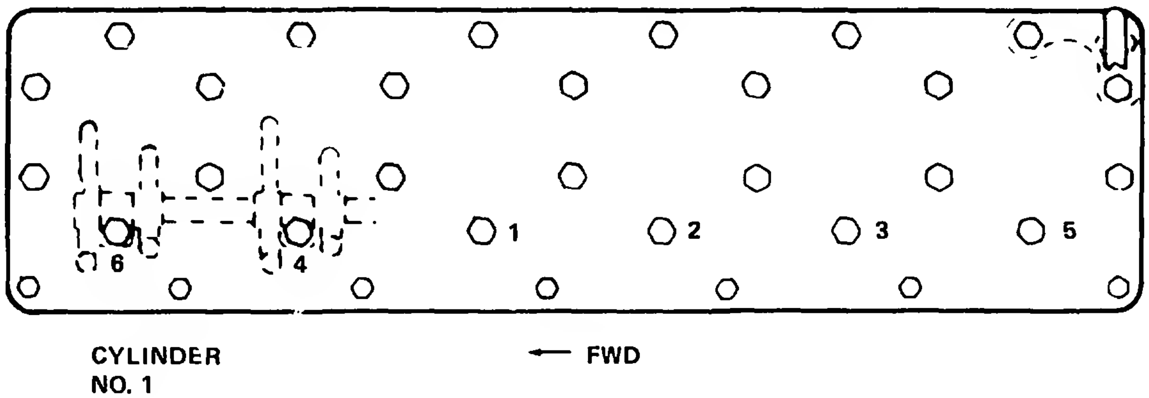
p. Tighten bolts (2) in face of water pump.

q. Install bolts (1) which secure the water pump to the cylinder head.

r. Refer to the Operator and Organizational Maintenance Manual and install the coolant thermostat, exhaust manifold, turbocharger, fuel injection and ether lines, and any parts of the housing removed for ease of access.

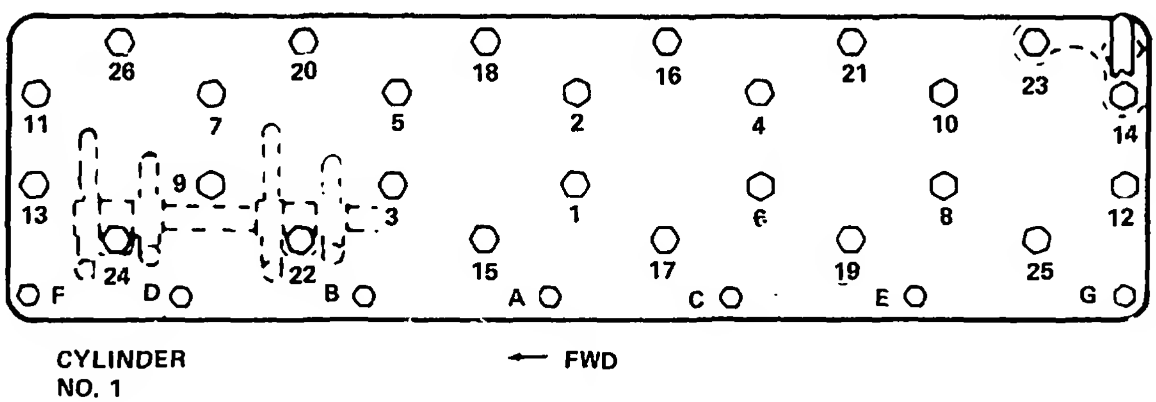
s. Adjust valve clearance and install valve cover and gasket in accordance with the Operator and Organizational Maintenance Manual.

t. Refill cooling system and check oil level in accordance with the Operator and Organizational Maintenance Manual.



TORQUE PATTERN FOR ROCKER ARM BOLTS (WHEN CYLINDER HEAD HAS NOT BEEN REMOVED).

A



TORQUE PATTERN FOR ROCKER ARM AND CYLINDER HEAD BOLTS (WHEN CYLINDER HEAD HAS BEEN REMOVED).

B

Figure 11-34. Rocker Arm and Cylinder Head Bolt Torque Patterns

Section V. MAINTENANCE OF OIL PAN

11-16. GENERAL. The oil pan is bolted to the bottom of the engine and serves as a reservoir for lubricating oil. The oil pump draws oil from the pan for circulation through the engine block. The oil pan contains an oil heater tube with external water connections.

11-17. REPLACEMENT.

WARNING

Disconnect negative battery cable before performing any engine maintenance procedure.

a. Remove engine assembly from the generator set in accordance with Chapter 2.
b. Remove dipstick (1, figure 11-35), tube (2), and connection (3).
c. Remove two external water connections (4).
d. Disconnect oil drain fitting (5) and remove plug (6).
e. Remove all bolts (7, 10, and 13), lockwashers (8, 11, and 14), and washers (9, 12, and 15).
f. Remove and discard gasket (16).
g. Remove bolts (17), locks (18), and clips (19). Remove heater tube (20) from oil pan (21).
h. Insert oil heater tube (20) into oil pan (21). Secure with clips (19), locks (18), and bolts (17).
i. Place new gasket (16) onto lip of oil pan (21).
j. Mount oil pan (21) and gasket (16) using bolts (7, 10, and 13), lockwashers (8, 11, and 14), and washers (9, 12, and 15).
k. Install plug (6) and oil drain fitting (5).
l. Attach external water connections (4) to oil heater tube (20).
m. Install connection (3), tube (2), and dipstick (1).
n. Install engine assembly in accordance with Chapter 2.

11-18. REPAIR.

WARNING

Cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

a. Flush interior of oil pan with cleaning solvent, P-D-680, Type II, and dry thoroughly. Use a stiff brush to remove encrusted sediment from bottom of pan.

WARNING

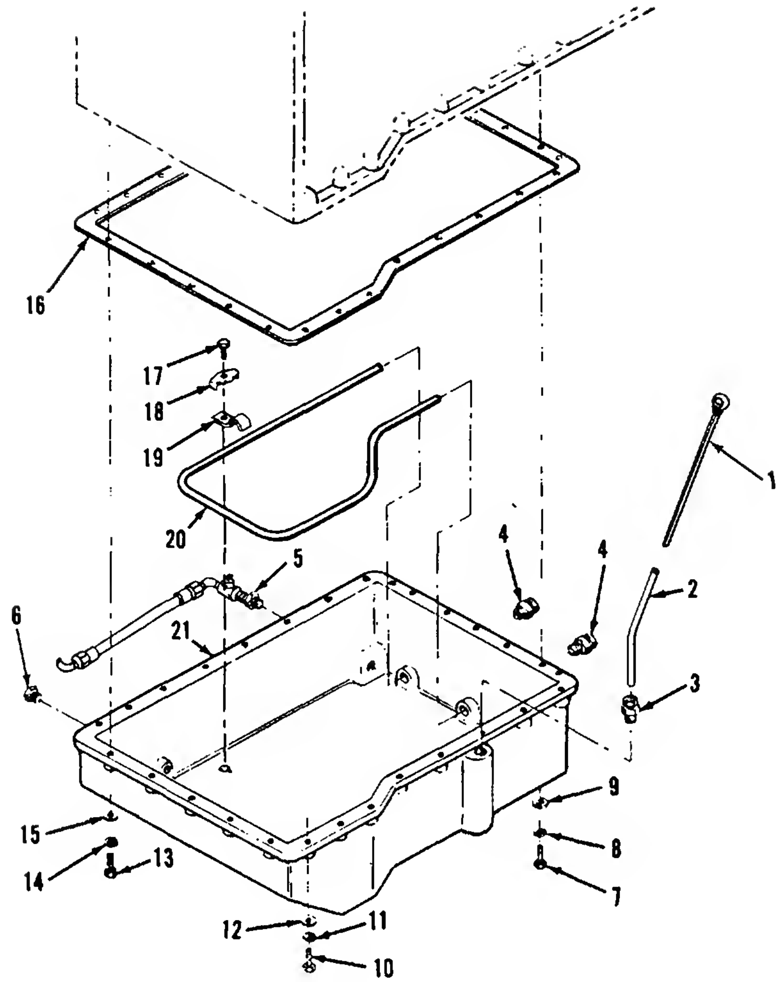
Cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

b. Flush tube (2) with cleaning solvent, P-D-680, Type II, and dry thoroughly.

WARNING

Cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

c. Flush oil heater tube (20) with cleaning solvent, P-D-680, Type II, to remove calcium deposits, and dry thoroughly.
d. Remove minor nicks and burrs from oil pan (21) using a file or hone.
e. Repair minor thread damage using a thread chaser.
f. Repair damaged or defective oil heater tube (20), connections (3 and 4), fitting (5), plug (6), clips (19), and locks (18) by replacement.



1. OIL LEVEL (DIPSTICK)
2. TUBE
3. CONNECTION
4. CONNECTION
5. OIL DRAIN FITTING
6. PLUG
7. BOLT
8. LOCKWASHER
9. WASHER
10. BOLT
11. LOCKWASHER
12. WASHER
13. BOLT
14. LOCKWASHER
15. WASHER
16. GASKET
17. BOLT
18. LOCK
19. CLIP
20. OIL HEATER TUBE
21. OIL PAN

Figure 11-35. Oil Pan, Removal and Installation

Section VI. MAINTENANCE OF OIL PUMP

11-19. GENERAL. The oil pump is mounted on the bottom face of the cylinder block at the front of the engine. The pump is a two-section, positive displacement, gear-type pump. One section scavenges oil from the rear of the engine and dumps it into the oil pan. The other section supplies lubrication, under pressure, to the basic engine through passages in the cylinder block, and to external components through oil lines. The pump is driven by the crankshaft through the oil pump idler gear.

11-20. REPLACEMENT.

a. Refer to the Operator and Organizational Maintenance Manual to the drain lubricating oil and cooling system.

b. Remove engine assembly from generator set housing in accordance with Chapter 2.

c. Remove oil pan in accordance with paragraph 11-17.

d. Remove bolt and lockplate (1 and 5, figure 11-36) which secures the suction bell to the oil pan plate.

e. Remove bolts (2) from scavenge pump tube.

NOTE

Weight of oil pump (4) is 30 pounds (14 kg).

f. Remove bolts (3 and 6) and lockplate (7) and remove oil pump (4).

g. Remove oil pan plate (14, figure 11-37) and scavenge pump tube (13) as follows:

(1) Remove bolts (1 and 3), washers (2 and 4) to remove left hand-plate (5) and right-hand plate (6).

(2) Remove bolts (7) and lockwashers (8) to remove oil pan plate (14) from the cylinder block.

(3) Remove and discard gasket (9).

(4) Remove bolt (10), lockplate (11), and clip (12) to remove scavenge pump tube (13) from oil pan plate (14).

h. Install oil pan plate (14, figure 11-37) and scavenge pump tube (13) as follows:

(1) Mount scavenge pump tube (13) onto oil pan plate (14) using clip (12), lockplate (11), and bolt (10).

(2) Position new gasket (9) on plate (14).

(3) Install oil pan plate (14) and gasket (9) using bolts (7) and lockwashers (8).

(4) Install left-hand plate (5) and right-hand plate (6) using bolts (1 and 3) and washers (2 and 4).

i. Mount oil pump (4, figure 11-36) using bolts (3 and 6) and lockplate (7).

j. Install bolts (2) for scavenge pump tube.

k. Install bolt (1) and lockplate (5) which secures suction bell to oil pan plate.

m. Install oil pan in accordance with paragraph 11-17.

n. Install fuel burning heater in accordance with Chapter 13.

o. Install the engine assembly into the generator set in accordance with Chapter 2.

p. Service lubricating oil and cooling systems in accordance with the Operator and Organizational Maintenance Manual.

11-21. DISASSEMBLY OF OIL PUMP.

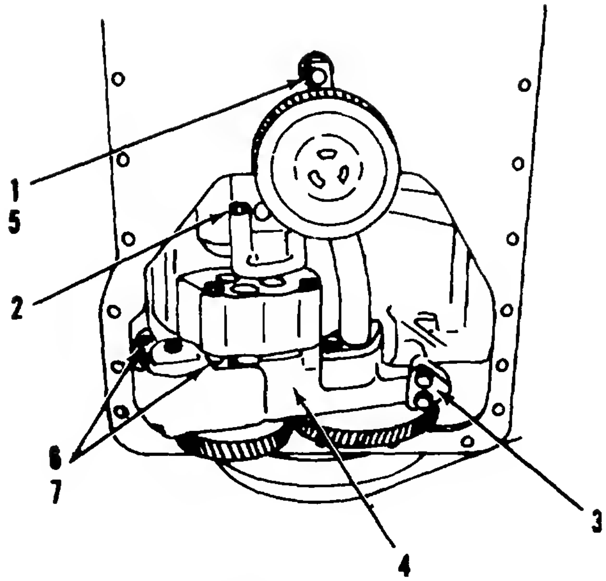
a. Remove idler gear (1, figure 11-38). Remove bearing (2) only if necessary for replacement.

b. Remove screws (3), then remove suction bell (4) and retainer (5).

c. Remove bolt (6) and washer (7). Remove drive gear (8).

d. Remove key (9).

e. Remove bolts (10) and washers



1. BOLT
2. BOLT
3. BOLT
4. OIL PUMP
5. LOCKPLATE
6. BOLT
7. LOCKPLATE

Figure 11-36. Oil Pump, Removal and Installation

(11) from pump housing (13). Separate housing (13) from pump body (26). Remove bearings (12) from housing (13) only if necessary for replacement.

f. Use a puller to remove gears (14).

g. Remove keys (15), and remove spacer (16) from pump body (26).

h. Remove idler shaft (17), and drive gear shaft (18). Remove gears (19) from shafts.

i. Remove bolt (20), washer (21), cover (22), and pressure relief valve (23) from pump body (26).

j. Remove bearings (24) from pump body (26) only if necessary for replacement.

k. Remove idler gear shaft (25) from pump body (26).

11-22. INSPECTION.

a. Inspect gear teeth for nicks, burrs, cracks, and broken teeth. Nicks and burrs that extend below the hardened surface of the gear teeth are cause for rejection of gear.

b. Inspect gear teeth for wear that may have destroyed the original tooth shape. If this condition is found, replace gear.

c. Refer to table 1-3 and, using micrometer and feeler gage, check wear measurements for drive gear shaft (18), idler shaft (17), and idler gear shaft (25). Check outside diameter of pressure relief valve (23) spring and gear to cover clearance.

d. Inspect components for dents, cracks, distortion, and damaged threads.

e. Inspect oil pan plate (13, figure 11-37) for dents, cracks, distortion, warpage, and damaged threads.

11-23. REPAIR

a. Repair minor nicks and burrs using a file or hone.

b. Repair minor thread damage using a thread chaser.

11-24. ASSEMBLY.

a. Install idler gear shaft (25, figure 11-38) into pump body (26).

b. If removed, install bearings (24) into body (26).

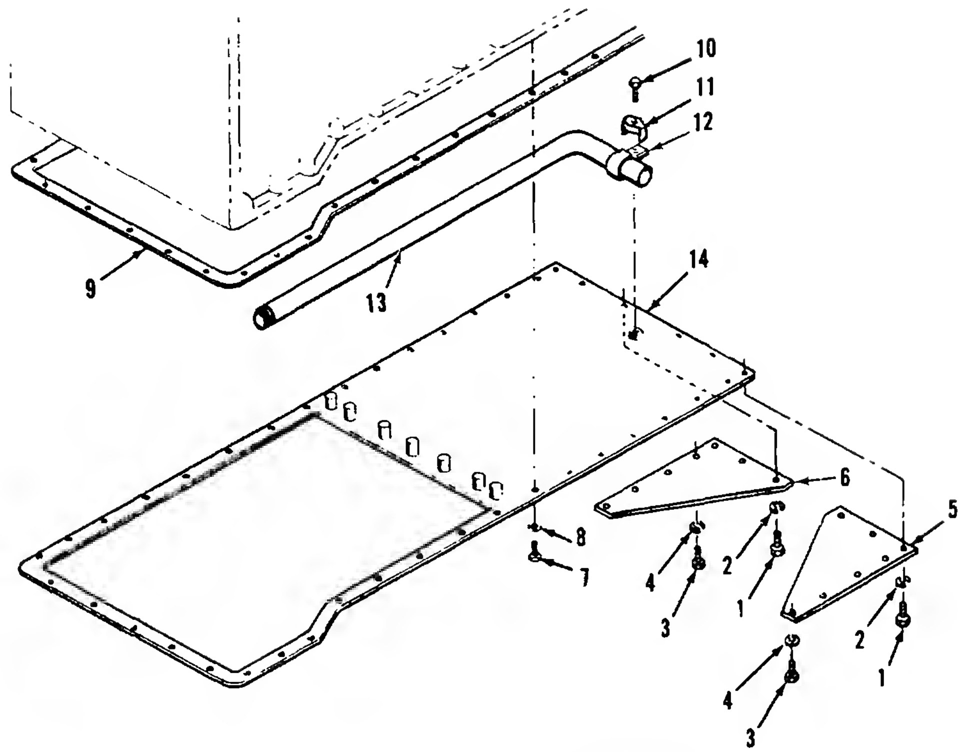
c. Install pressure relief valve (23) and cover (22) using washer (21) and bolt (20).

d. Lubricate gears (19) and shafts (18 and 17) with clean engine oil.

e. Install gears onto shafts, and insert shafts into body (26).

f. Install spacer (16) and key (15).

g. Install gears (14) onto shafts (18 and 17).



1. BOLT
2. LOCKWASHER
3. BOLT
4. LOCKWASHER
5. PLATE, LEFT HAND
6. PLATE, RIGHT HAND
7. BOLT
8. LOCKWASHER
9. GASKET
10. BOLT
11. LOCKPLATE
12. CLIP
13. SCAVENGE PUMP TUBE
14. OIL PAN PLATE

Figure 11-37. Oil Pan Plate, Removal and Installation

h. If removed, install bearings (12).

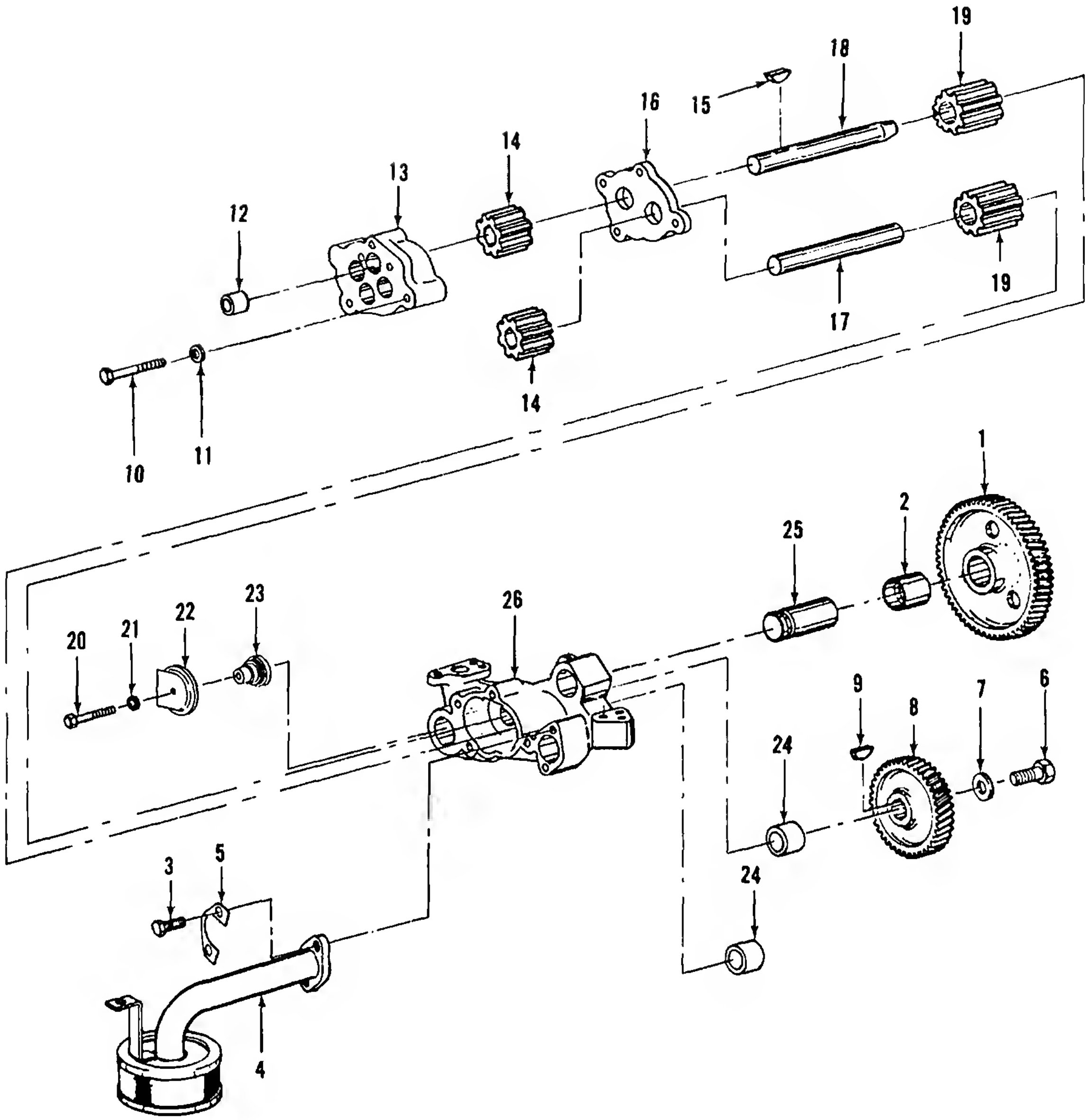
i. Install pump housing (13) and secure with bolts (10) and washers (11).

j. Install key (9) and drive gear (8). Secure gear with bolt (6) and washer (7). Torque bolt (7) to 32 +/-5 foot-pounds (43.4 +/-6.8 Newton-meters).

k. Install suction bell (4) using retainer (5) and screws (3).

l. If removed, install bearing (2).

m. Install idler gear (1) onto shaft (refer to figure 11-47).



1.	IDLER GEAR	10.	BOLT	19	GEAR
2.	BEARING	11.	WASHER	20.	BOLT
3.	SCREW	12.	BEARING	21.	WASHER
4.	SUCTION BELL	13.	PUMP HOUSING	22.	COVER
5.	RETAINER	14.	GEAR	23.	PRESSURE RELIEF VALVE
6.	BOLT	15.	KEY	24.	BEARING
7.	WASHER	16.	SPACER	25.	SHAFT
8.	DRIVE GEAR	17.	SHAFT	26.	PUMP BODY
9.	KEY	18.	SHAFT		

Figure 11-38. Oil Pump, Exploded View

Section VII. MAINTENANCE OF CONNECTING RODS AND PISTONS GROUP

11-25. GENERAL. The connecting rods and pistons group is located in the cylinder block. The connecting rods and pistons group consists of the piston connecting rods, bearings, pins, and retainers. The vertical movement of each piston is transmitted through its connecting rod to the crankshaft. The action of the connecting rods on the crankshaft converts the vertical movement of the pistons into rotary motion.

11-26. REMOVAL AND DISASSEMBLY.

a. Refer to the Operator and Organizational Maintenance Manual to drain lubricating oil and cooling systems.

b. Remove engine assembly from housing in accordance with Chapter 2.

c. Remove the cylinder head assembly group in accordance with paragraph 11-10.

d. Remove the oil pan in accordance with paragraph 11-17.

e. Remove the oil pump and oil pan plate in accordance with paragraph 11-20.

f. Clean any carbon deposit ridges from top inside walls of cylinder liners with ridge reamer and fine emery cloth.

g. Turn the crankshaft until two pistons are at bottom center.

NOTE

Keep connecting rod and piston assembly parts for each cylinder together. Tag all parts to ensure correct mating of parts during assembly and installation.

h. Remove nut (1, figure 11-39) and bolt (2) to remove connecting rod cap (3).

i. Remove and tag lower (exposed) bearing half.

CAUTION

Take care to ensure that cylinder liners are not damaged during this procedure.

j. Push connecting rod body (16) and piston assembly (5) upward until rings (6, 7, and 8) are clear of cylinder liner. Grasp piston from the top and pull up to remove it from the block. Tag the connecting rod body (16).

k. Remove and tag remaining bearing half (4).

l. Repeat steps g, h, i, and j until all connecting rods (16) and piston assemblies (5) are removed.

m. Remove rings (6, 7, and 8) from piston assembly (5).

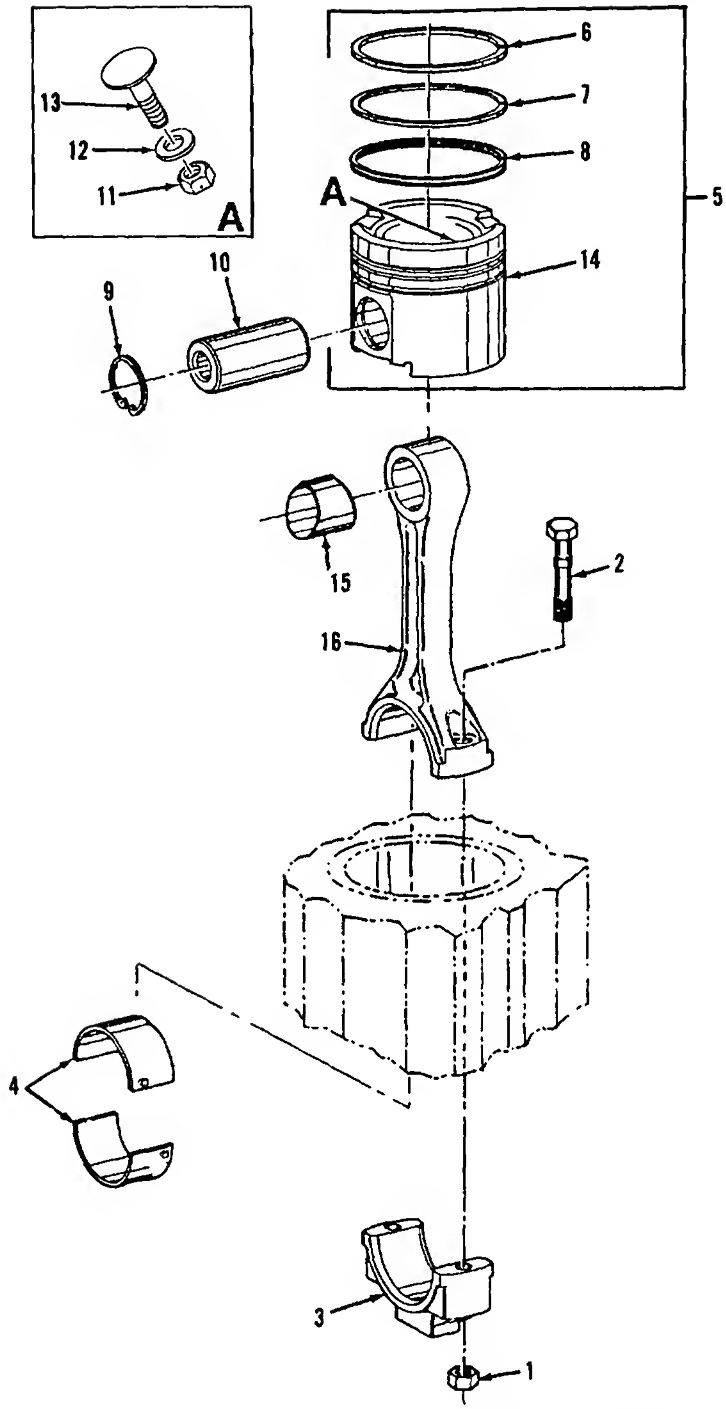
n. Remove retainers (9) and pin (10) from piston assembly. This will separate the connecting rod body (16) from the piston assembly.

o. Remove piston pin bearing (15) from connecting rod body (16) if it needs to be replaced.

11-27. INSPECTION.

a. Inspect piston body (14) and plug (13) for burned condition, cracks, distortion, galling, or any other defects. Check mating surfaces for damaged or defective parts.

b. Inspect piston pins (10), piston pin bearings (15), and connecting rod bearing halves (4) for scoring, galling, distortion or cracking. Replace damaged or defective parts.



1. NUT	9. RETAINER
2. BOLT	10. PISTON PIN
3. CONNECTING ROD CAP	11. NUT ASSY
4. CONNECTING ROD BEARING HALF	12. WASHER
5. PISTON ASSEMBLY	13. PLUG
6. TOP RING	14. PISTON BODY
7. INTERMEDIATE RING	15. PISTON PIN BEARING
8. OIL CONTROL RING	16. CONNECTING ROD BODY

Figure 11-39. Connecting Rod and Piston, Exploded View

NOTE

Connecting rod bearing halves (4) must be replaced as a matched set (two halves comprise a set) if either half is damaged. Abrasive materials may cause scratches on the bearing halves which are not harmful and do not necessitate replacement.

c. Inspect connecting rod body (16) and cap (3) for cracks, breaks, bending, or distortion. Check mating surfaces for damage, defect, alignment, and fit. Bent rods must be replaced. Do not attempt to align rods by bending. Replace damaged or defective connecting rod body (16) and cap (3) as a matched set.

d. Refer to table 1-3 and use a micrometer and feeler gage to inspect parts for dimensional tolerances.

e. To measure clearance and gap for each piston ring (6, 7, and 8), insert a piston body (14) in cylinder bore in the inverted position. Insert each piston ring, one at a time, about 2 inches (50.8 mm) down in the cylinder bore and bring the bottom edge of the piston body (14) up against the ring to square the ring in the cylinder bore. Check gap with a feeler gage. If gap clearance for any ring is not as specified in table 1-3, the ring must be replaced.

f. Determine connecting rod bearing clearance as follows:

(1) Place a piece of soft plastic measuring strip (per Military Specification L-P-525A) between the crankshaft journal and lower bearing half (4).

(2) Assemble bearing halves (4), connecting rod body (16) and cap (3) in place on the crankshaft. Secure by torquing bolt (2) and nut (1) to 30 +/-3 foot-pounds (40.68 +/-4.07 Newton-meters).

(3) Disassemble and remove connecting rod body (16), cap (3), and bearing halves (4). Measure thickness of plastic strip. If the bearing clearance on any connecting rod bearing exceeds 0.010 inch (0.25 mm), replace the connecting rod bearings for all six cylinders.

11-28. ASSEMBLY AND INSTALLATION.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

a. Clean all parts with cleaning solvent (P-D-680, Type II) and dry thoroughly.

CAUTION

Do not use broken piston rings or carbon scrapers on ring lands since this practice can result in cutting sides of grooves. Be sure bottom of each ring groove is clean and oil return holes in oil ring groove are open.

b. If pistons have carbon on them, soak pistons in cold water overnight and then let them dry (preferably in sunlight). Most of the carbon can then be removed with a hardwood stick.

c. Install piston pin bearing (15) into connecting rod body (16), if removed. Machine bearing to proper centerline-to-centerline (wrist pin to crankshaft) dimension. Hone bearing to proper piston fit.

d. Install rings (8, 7, and 6) onto piston body (14). Position each ring with inprint "UP" facing top of piston, and ensure that gaps in each ring are at least 90 degrees apart.

NOTE

Retainer (9) should be installed with opening at 6 o'clock position.

e. Lubricate piston pin bearing (15) with clean engine oil and assemble connecting rod body (16) and piston body (14) with rod identification mark on the same side as the "V" mark on piston. Secure with piston pin (10) and retainer (9).

f. Lubricate piston rings (6, 7, and 8), cylinder liner walls, and bearing halves (4) with clean engine oil.

CAUTION

Ensure that protruding tabs on bearing halves (4) line up with recesses in connecting rod body (16) and cap (3). Ensure that cylinder liner walls and crankshaft bearing surfaces are not damaged during this procedure.

g. Use a ring compressor and guide piston and rod into liner bore with "V" mark on piston in alignment with "V" mark on cylinder block.

h. Carefully seat upper bearing half (4) and connecting rod body (16) onto crankshaft.

i. Lubricate lower bearing half (4) and bolt (2). Install lower bearing half (4) and connecting rod cap (3) using bolt (2) and nut (1). Torque to 30 +/-3 foot-pounds (41 +/-4 Newton-meters).

j. Mark nuts and caps with a horizontal line. Tighten an additional 90 +5 degrees from this mark.

k. Install oil pan plate and oil pump in accordance with paragraph 11-20.

l. Install the oil pan in accordance with paragraph 11-17.

m. Install the cylinder head assembly in accordance with paragraph 11-15.

n. Install engine assembly into generator set in accordance with Chapter 2.

o. Refer to the Operator and Organizational Maintenance Manual and service lubricating oil and cooling systems.

Section VIII. MAINTENANCE OF CYLINDER LINER SLEEVES

11-29. GENERAL. The cylinder liner sleeves are set into the cylinder block from top and extend downward into the block. The liners serve to insulate and reinforce the cylinder block against the force of combustion during engine operation and against wear due to the action of the pistons.

11-30. REMOVAL.

a. Remove engine assembly from generator set in accordance with Chapter 2.

NOTE

Do not remove spacer plate (48, figure 11-32), seal ring (49) or spacer plate gasket (50) until the cylinder liners have been removed.

b. Remove pistons in accordance with paragraph 11-26. During removal of cylinder head assembly group, do not remove spacer plate (48, figure 11-32), seal ring (49), or spacer plate gasket (50).

c. Cover journals of crankshaft for protection from dirt and water.

d. Use a cylinder liner puller to remove cylinder liners (see figure 11-40). Tag liners to ensure proper reassembly.

e. Remove spacer plate (48, figure 11-32), seal ring (49), and spacer plate gasket (50) in accordance with paragraph 11-10.

f. Remove and discard filler band and seal rings (see figure 11-41).

11-31. INSPECTION.

a. Inspect cylinder liners for cracking, scoring, distortion and other damage or defect.

b. Inspect cylinder bore for out-of-round condition.

c. Refer to table 1-3 and, using a micrometer and feeler gage, check for excessive wear by measuring cylinder liner bore, thickness of flange on liner, and cylinder liner projection. Measure liner projection as follows:

(1) Clean cylinder liners and liner bores in cylinder block thoroughly. Use a stiff brush to remove rust and scale from outside surfaces of cylinder liners.

(2) Put spacer plate and gasket into place on cylinder block.

NOTE

Do not install cylinder liner seals or filler band during this procedure.

(3) Use a cylinder liner installation tool to insert the cylinder liners into the cylinder block without seal rings or filler band.

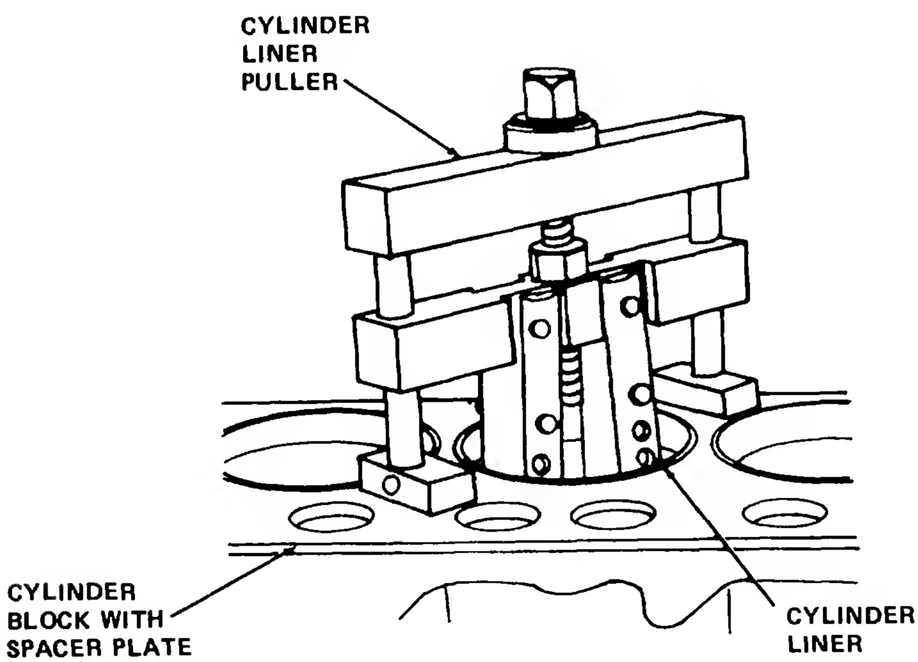


Figure 11-40. Cylinder Liner Removal

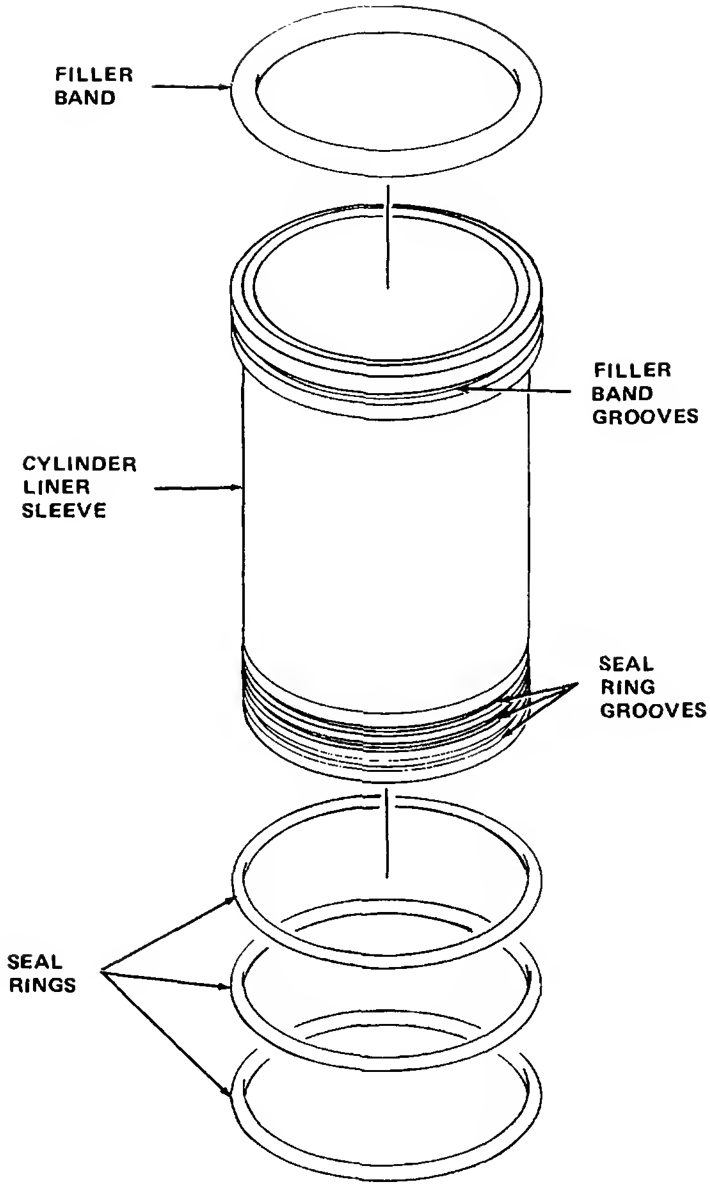


Figure 11-41. Cylinder Liner, Exploded View

(4) Install bolts (Special Tool S1589, 1, figure 11-42) and washers (Special Tool 1S379, 2) next to each liner. Torque the bolts evenly in four steps: 10 foot-pounds (14 Newton-meters), 25 foot-pounds (35 Newton-meters), 50 foot-pounds (70 Newton-meters), and 70 foot-pounds (95 Newton-meters).

(5) Put adapter plate (Special Tool 1P2394, 3) on top of the liner and install a puller crossbar (Special Tool 8B7548, 4) with bolts (Special Tool 1D4595, 5) and washers (Special Tool 2S736, 6) and two plates (Special Tool 3H465, 7). Torque bolts (5) evenly in four steps: 5 foot-pounds (7 Newton-meters), 15 foot-pounds (20 Newton-meters), 25 foot-pounds (35 Newton-meters), and 50 foot-pounds (70 Newton-meters).

(6) Check to ensure that the distance from the bottom edge of the crossbar (4) to the top of the cylinder block is the same on both sides of the liner.

(7) Install the contact point (Special Tool 1P5512) onto the dial indicator (Special Tool 1P2403). Put the dial indicator in the gage body (Special Tool 1P2402). To adjust the dial indicator to zero, put the assembled dial indicator and gage body on the gage (Special Tool 1P5507). Move the dial indicator until the hand moves one-quarter turn. Tighten bolt on body to hold the dial indicator in this position. Turn the dial face until the zero is in alignment with the hand.

(8) Measure the cylinder liner projection as close as possible to the four corners of the adapter plate on the liners. The liner projection must be 0.0013 to 0.0069 inch (0.0330 to 0.1750 mm). The difference between the four measurements must not be more than 0.002 inch (0.05 mm). The difference in the average cylinder liner projection of adjacent liners must not exceed 0.002 inch (0.05 mm).

NOTE

If liner projection changes from point to point around the liner, turn the liner to a new position in the bore. If the liner projection is still not to specifications, move the liner to a different bore.

(9) When cylinder liner projection is correct, put a temporary marking on the liner and on the spacer plate to indicate exact alignment for installation.

(10) Cylinder liner projection can be adjusted by the use of shims or by counterboring. Refer to table 1-3 for specifications of shims and refer to paragraph 11-59, Cylinder Block Repair, for instructions on counterboring.

11-32. INSTALLATION.

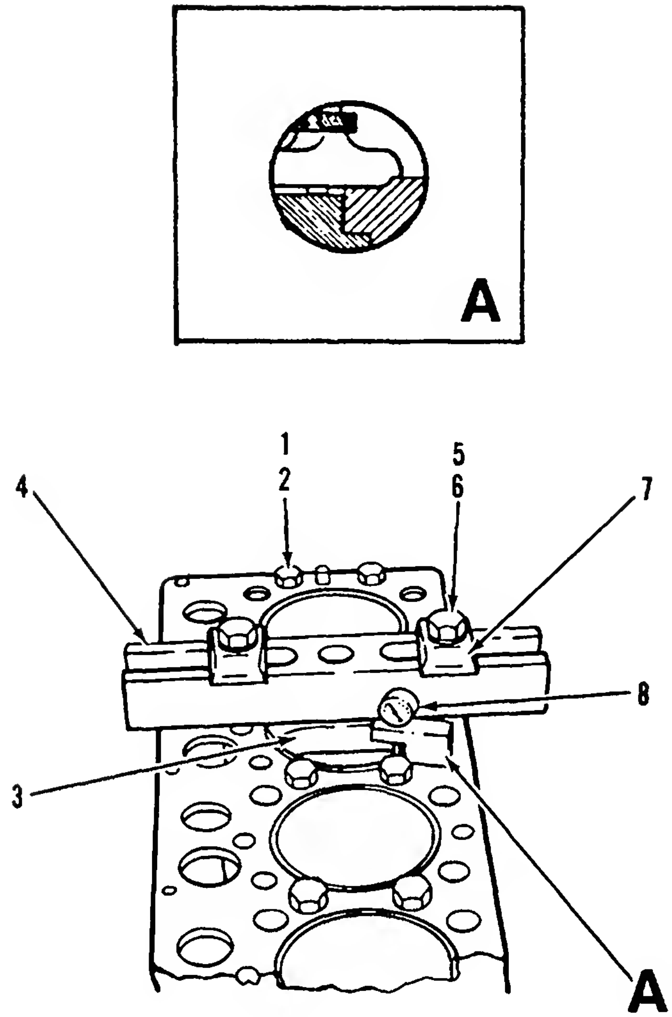
a. Install spacer plate gasket (50, figure 11-32), seal (49), and spacer plate (48), in accordance with paragraph 11-15.

b. Put liquid soap, Federal Specification P-D-220C, on the lower portion of the liner bore in block, on the seal ring grooves on bottom of liner, and on the seal rings (see figure 11-41).

NOTE

This step must be performed quickly, before the filler band begins to expand after absorbing oil.

c. Put filler band in clean engine oil, SAE 30 (MIL-L-2104C), for a moment and install immediately in liner. Install liner into cylinder block immediately (before filler band expands) using a cylinder liner installation tool.



1. BOLTS
2. WASHER (COPPER)
3. ADAPTER PLATE
4. PULLER CROSSBAR
5. BOLTS
6. WASHER
7. PLATES
8. DIAL INDICATOR

Figure 11-42. Measuring Cylinder Liner Projection

d. Ensure that cylinder liner is correctly positioned by aligning markings made during liner projection measurement (refer to paragraph 11-31).

e. Install pistons and reassemble engine (refer to paragraph 11-28).

f. Install engine assembly into generator set in accordance with Chapter 2.

Section IX. MAINTENANCE OF FLYWHEEL ASSEMBLY

11-33. GENERAL. The flywheel assembly is mounted on the rear of the engine crankshaft. The flywheel assembly consists of a flywheel and ring gear subassembly. The ring gear is shrink-fitted to the rim of the flywheel. The purpose of the flywheel is to provide a mass at the end of the crankshaft to smooth out power impulses and reduce variations in the rotative speed of the crankshaft. The flywheel also serves as mounting surface for the generator coupling disc. The ring gear provides a place for starting motor engagement when cranking the engine. The flywheel housing provides machined surfaces for mounting the generator adapter flange and engine support brackets and starter motor.

11-34. REMOVAL AND DISASSEMBLY.

a. Remove engine assembly from the generator set in accordance with Chapter 2.

b. Remove bolt (1, figure 11-43), lockwasher (2), and timing gear cover (3).

c. Refer to figure 11-44 and remove the timing pin bolt and the timing pin.

d. Remove bolts (4, figure 11-43), lockwashers (5), and cover (6).

e. Remove pointer (7).

NOTE

One flywheel bolt must remain in place until a guide pin can be installed.

f. Remove all but one of the flywheel bolts (8).

g. Install a guide pin through a flywheel bolt hole and into the crankshaft to facilitate installation. Mark the guide pin and flywheel for alignment.

h. Remove lockring (9).

NOTE

Weight of the flywheel and ring gear assembly (10) is 214 pounds (97 kg).

i. Install an eyebolt, for lifting the flywheel and ring gear assembly (10), into the tapped hole on the flywheel.

j. Fasten a hoist (capable of lifting 1/2-ton (454 kg) minimum) and remove the flywheel and ring gear assembly (10).

NOTE

Do not remove ring gear (11) from flywheel (12) unless necessary for replacement.

k. If necessary, remove ring gear (11) from flywheel (12).

l. Remove crankshaft rear seal (14). Discard seal.

m. Remove wear sleeve (13) and discard wear sleeve.

n. Refer to the Operator and Organizational Maintenance Manual and remove starter assembly.

o. Remove bolts (15) and washers (16) which hold the oil pan plate to the flywheel housing (26). Loosen but do not remove those bolts (17) which hold the oil pan plate to the cylinder block.

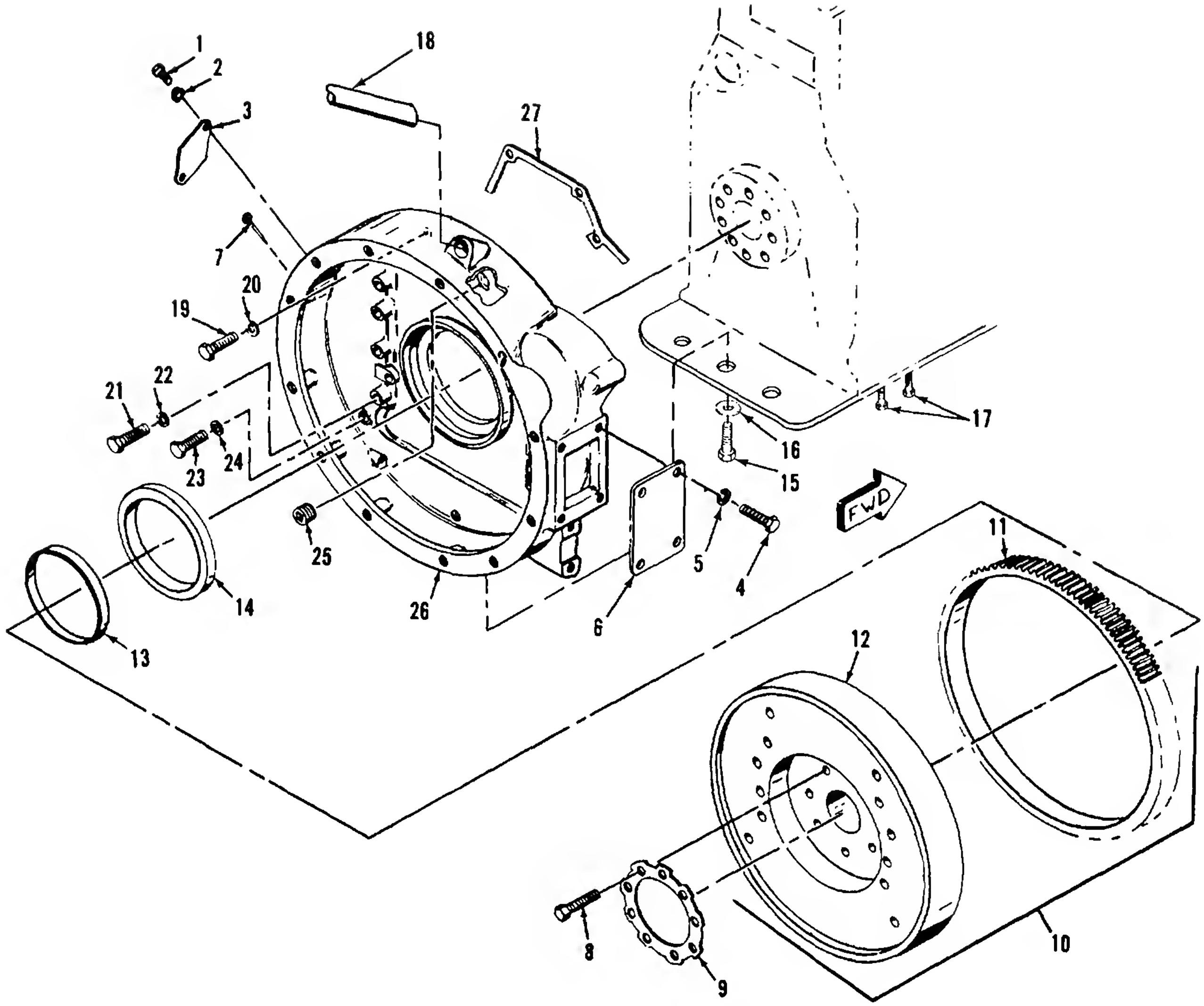
p. Install a thin spacer between the cylinder block and the oil pan plate (bolt sides to hold plate clear of flywheel housing).

q. Remove the turborcharger oil drain line (18).

WARNING

Weight of flywheel housing (26) is 128 pounds (58 kg).

r. Install lifting slings through timing hole and through starter shaft housing.



1. BOLT
2. LOCKWASHER
3. TIMING MARK COVER
4. BOLT
5. LOCKWASHER
6. COVER
7. POINTER
8. FLYWHEEL BOLT
9. LOCK RING
10. FLYWHEEL AND RING GEAR ASSY
11. RING GEAR
12. WHEEL
13. WEAR SLEEVE
14. CRANKSHAFT REAR SEAL
15. BOLT
16. WASHER
17. BOLT
18. TURBOCHARGER OIL DRAIN LINE
19. BOLT
20. WASHER
21. BOLT
22. WASHER
23. BOLT
24. WASHER
25. PLUG
26. FLYWHEEL HOUSING
27. GASKET

Figure 11-43. Flywheel Assembly, Removal and Installation

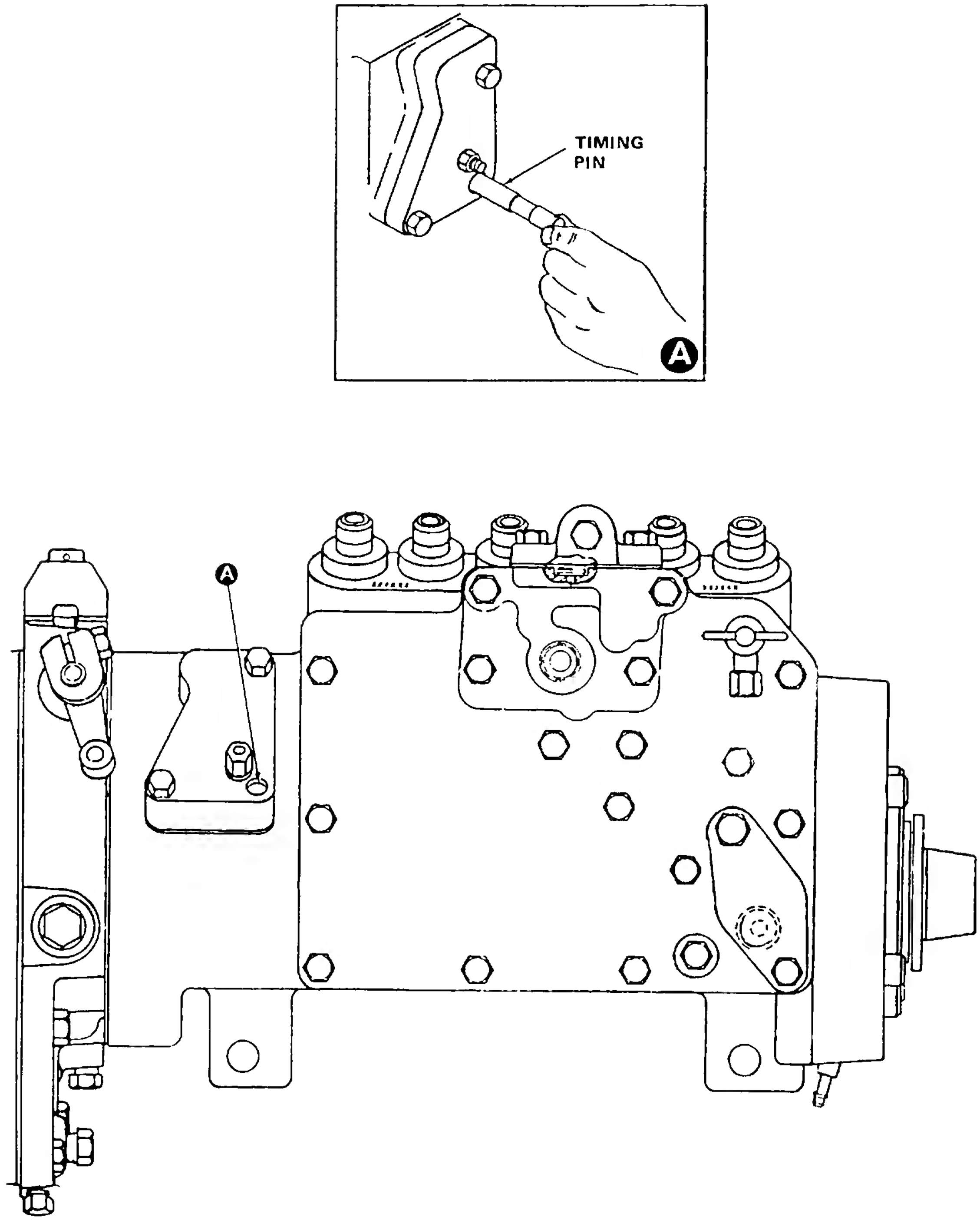


Figure 11-44. Timing Pin, Removal and Installation

s. Remove flywheel housing bolts (19, 21, and 23) and washers (20, 22, and 24). Note specific locations of bolts (19 and 23).

t. Use a hoist to remove flywheel housing (26).

u. Remove and discard gasket (27).

11-35. INSPECTION.

a. Inspect flywheel housing (26) for cracking. Inspect machine gasket surface for nicks and burrs.

b. Inspect all threaded holes for damaged threads.

c. Inspect ring gear (11) for nicks, turns, cracks, and broken teeth. Check for worn or misshappen teeth.

d. Inspect coupling disc counterbore on flywheel (12) for burred edges, scoring, or other indication that coupling disc does not seat properly.

11-36. REPAIR.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

a. Clean all parts with cleaning solvent, P-D-680, Type II, and dry thoroughly.

b. Remove rust from ring gear (11) using a stiff brush.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic, to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

c. Flush out turbo oil drain port in housing (26) with solvent (P-D-680, Type II) and dry with low pressure compressed air.

d. Remove minor nicks and burrs from flywheel housing (26) and ring gear (11) teeth using a file or hone.

e. Remove sharp edges and burrs from flywheel (12) coupling disc counterbore using a file.

f. Repair nicks and burrs which extend below the hardened surface of the ring gear (11) teeth by replacement of the gear. Install new ring gear (11) as follows:

CAUTION

Do not heat ring gear (11) over 600°F (316.0°C) as excessive heat may destroy the original heat treatment. Do not heat the ring gear in one area.

(1) Heat new ring gear (11) to a maximum of 600°F (316.0°C). Apply heat evenly around diameter of ring gear.

(2) Install ring gear with chamfered portion of ring gear teeth facing toward starter pinion or towards front or forward side of flywheel. Gear must be flush with flywheel shoulder.

11-37. ASSEMBLY AND INSTALLATION.

NOTE

If ring gear (11) was removed from flywheel (12), refer to paragraph 11-36, above, and install new ring gear onto flywheel before proceeding.

a. Install a new gasket (27) on flywheel housing (26). Align with some of bolts (19, 21, or 23) and washers (20, 22, or 24).

b. Use hoist (capable of lifting 1/2-ton (454 kg) minimum) to position housing (26) against the cylinder block. Secure with bolts (19, 20, and 23) and washers (20, 22, and 24). Care should

be taken to install bolts (19 and 23) in their original location. Torque bolts to 32 +/-5 foot-pounds (43.4 +/-6.8 Newton-meters).

c. Trim gasket (27) to cylinder block. Install plug (25).

d. Install turbocharger oil drain line (18).

e. Remove spacers from between oil pan plate and the cylinder block.

f. Install bolts (15) and washers (16) which secure the oil pan plate to the flywheel housing (26). Tighten bolts (17) which hold the oil pan plate to the cylinder block.

g. Refer to the Operator and Organizational Maintenance Manual and install the starter assembly.

h. Install wear sleeve (13) and crankshaft rear seal (14) as follows:

(1) Install a locator (Special Tool 9S8871, refer to table 2-1) onto the crankshaft and secure using three bolts.

(2) Lubricate sealing lip of seal (14) and outside diameter of wear sleeve (13) with clean engine oil.

(3) Install seal (14) onto wear sleeve (13) from the end of the wear sleeve which is beveled on the outside diameter.

(4) Clean outside diameter of crankshaft flange and inside diameter of wear sleeve (13) with suitable quick cure primer, MIL-P-38336(1). Coat outside diameter of crankshaft flange and inside diameter of wear sleeve (13) with retaining compound (MIL-R-46082A).

NOTE

Ensure that lip of seal (14) is toward inside of engine and that bevel (on outside diameter of sleeve) is toward outside of engine when installed. Put MIL-S-22473 Sealant on the outer metal shell of the seal.

(5) Put wear sleeve (13) and seal (14) onto locator. Ensure that lip of seal (14) is toward the inside of engine and that the outside diameter bevel of wear sleeve (13) is toward the outside of the engine.

(6) Install wear sleeve (13) and seal (14).

i. Use a hoist (capable of lifting 1/2-ton (454 kg) minimum) to position flywheel and ring gear assembly (10) onto guide pin in crankshaft. Check alignment marks.

j. Secure the flywheel assembly (10) with lock ring (9) and all but one bolt (8). Remove guide pin and install remaining bolt (8). Torque bolts to 150 +/-20 foot-pounds (203 +/-27 Newton-meters).

k. Install pointer (7).

l. Install cover (6, figure 11-43) with bolts (4) and lockwashers (5).

m. Install timing gear cover (3) with bolts (1) and lockwashers (2).

n. Install engine assembly into the generator set in accordance with Chapter 2.

o. Check axial eccentricity (face runout) of the flywheel as follows:

(1) Install dial indicator as shown in figure 11-45 view A. Put a force on the flywheel towards the rear.

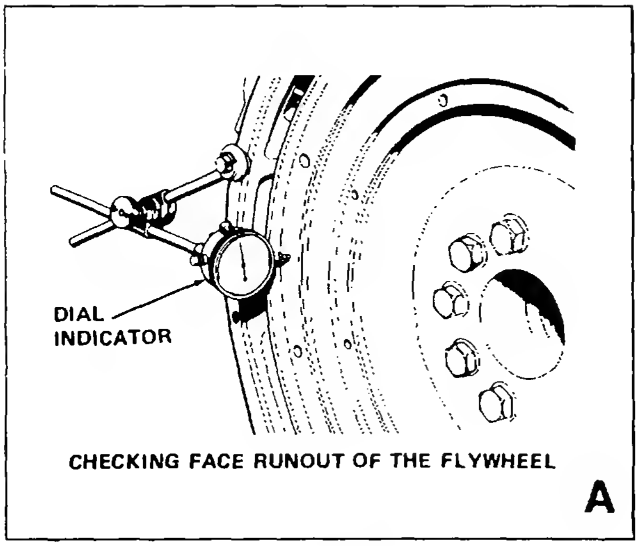
(2) Set the dial indicator to read 0.000 inches (0.00 mm).

(3) Turn the flywheel and read the indicator every 90 degrees. Put a force on the flywheel towards the rear before each reading.

(4) The difference between the lowest and highest measurements taken at all four points must not be more than 0.006 inches (0.15 mm), which is the maximum permissible axial eccentricity (face runout) of the flywheel.

p. Check the radial eccentricity (bore runout) of the flywheel as follows:

(1) Install a dial indicator as shown in figure 11-45 view B. Adjust universal attachment so it makes contact as illustrated.



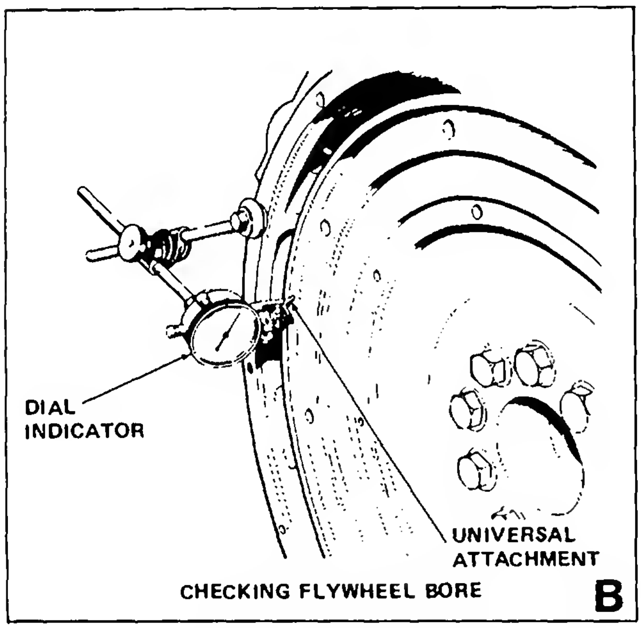


Figure 11-45. Checking Flywheel Eccentricity

(2) Set the dial indicator to read 0.000 inches (0.00 mm).

(3) Turn the flywheel and read the indicator every 90 degrees.

(4) The difference between the lowest and highest measurements take at all four points must not be more than 0.006 inches (0.15 mm), which is the maximum possible radial eccentricity (bore runout) of the flywheel.

q. Check the axial eccentricity of the flywheel housing as follows:

(1) Fasten a dial indicator to the crankshaft flange so the anvil of the indicator will touch the face of the flywheel housing (see figure 11-46 view A)

(2) Set dial indicator to read 0.000 inches (0.00 mm) at point A (see figure 11-46 view B).

(3) Turn the crankshaft and read the indicator at points B, C, and D. Put a force on the crankshaft towards the rear before reading the indicator at each point.

(4) The difference between the lowest and highest measurements taken at all four points must not be more than 0.012 inches (0.30 mm), which is the maximum permissible axial eccentricity (face runout) of the flywheel housing.

r. Check flywheel housing bore eccentricity as follows:

(1) Install dial indicator and universal attachment as shown in figure 11-46 view C.

NOTE

Write the dial indicator measurements with their positive (+) and negative (-) notations (signs). This notation is necessary for making the calculations in the chart correctly.

(2) Refer to figure 11-46 view B and, with the dial indicator in position at point C, adjust the indicator to read 0.000 inch (0.00 mm). Push the crankshaft up against the top bearing. Write the measurement for bearing clearance on line I in column C of chart (see figure 11-46 view D).

(3) Divide the measurement from step 1 by 2. Write this number on line I in columns B and D.

(4) Turn the crankshaft to put the dial indicator at A. Adjust the dial indicator to read 0.000 inch (0.00 mm).

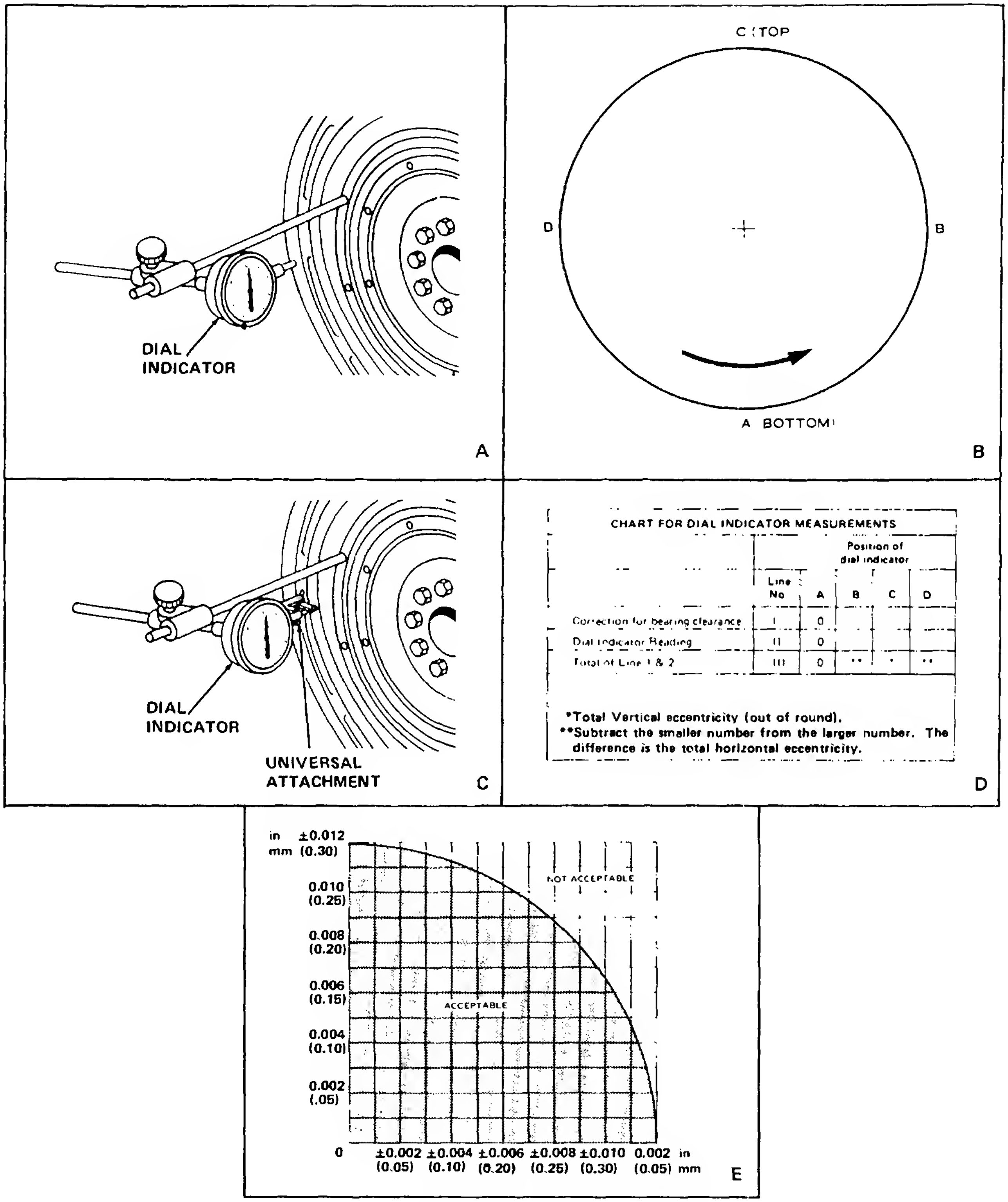


CHART FOR DIAL INDICATOR MEASUREMENTS

	Line No	Position of dial indicator			
		A	B	C	D
Correction for bearing clearance	I	0			
Dial Indicator Reading	II	0			
Total of Line 1 & 2	III	0	**	*	**

*Total Vertical eccentricity (out of round).
**Subtract the smaller number from the larger number. The difference is the total horizontal eccentricity.

Figure 11-46. Checking Flywheel Housing Eccentricity

(5) Turn the crankshaft counterclockwise to put the dial indicator at B. Write the measurement in the chart.

(6) Turn the crankshaft counterclockwise to put the dial indicator at C. Write the measurement in the chart.

(7) Turn the crankshaft counterclockwise to put the dial indicator at D. Write the measurement in the chart.

(8) Add lines I and II by columns.

(9) Subtract the smaller number from the larger number in line III in columns B and D. The result is the horizontal "eccentricity" (out of round). Line III, column C is the vertical eccentricity.

(10) On the graph for total eccentricity (figure 11-46 view E) find the point of intersection of the lines for vertical eccentricity and horizontal eccentricity.

(11) If the point of intersection is in the range marked "Acceptable", the bore is in alignment. If the point of intersection is in the range marked "Not Acceptable" perform Step 12.

(12) Loosen the bolts (19, 21, and 23, figure 11-43) holding the flywheel housing to the cylinder block. Hit the flywheel housing lightly with a hammer to put it in the correct position. Tighten the bolts holding the flywheel housing to the cylinder block and perform Steps 1 through 12 again.

Section X. MAINTENANCE OF THE TIMING GEARS

11-38. GENERAL. The timing gears are located at the front of the cylinder block, and are protected by the timing gear cover. The timing gears (see figure 11-47) are driven by the crankshaft through the crankshaft gear, and keep the rotation of the crankshaft, camshaft, and fuel injection pump camshaft in correct relation to each other. The crankshaft gear also drives the oil pump through the oil pump idler gear and drive gear.

11-39. REMOVAL OF TIMING GEAR COVER.

a. Remove engine assembly from the generator set in accordance with Chapter 2.

b. Refer to Operator and Organizational Maintenance Manual and remove the fan assembly, alternator, idler pulley assembly, and water pump.

c. Remove the crankshaft pulley, trunnion and trunnion support as follows:

NOTE

Vibration damper is oil filled and should not be punctured or dented.

(1) Remove bolts (1, figure 11-48) and washers (2) to remove adapter (3) and vibration damper (4).

(2) Loosen bolt (5) and washer (6).

(3) Insert a spacer between washer (6) and crankshaft pulley (7) to obtain a 1/8 inch (3.2 mm) space between the washer and the pulley. Then, using a puller, loosen the crankshaft pulley (7) from the crankshaft. Remove the puller and the spacer.

(4) Remove bolt (5), washer (6), and crankshaft pulley (7).

(5) Remove bolts (8) and washers (9) to remove the trunnion support cap (10), shims (11 and 12), support base (13), and bushing (14).

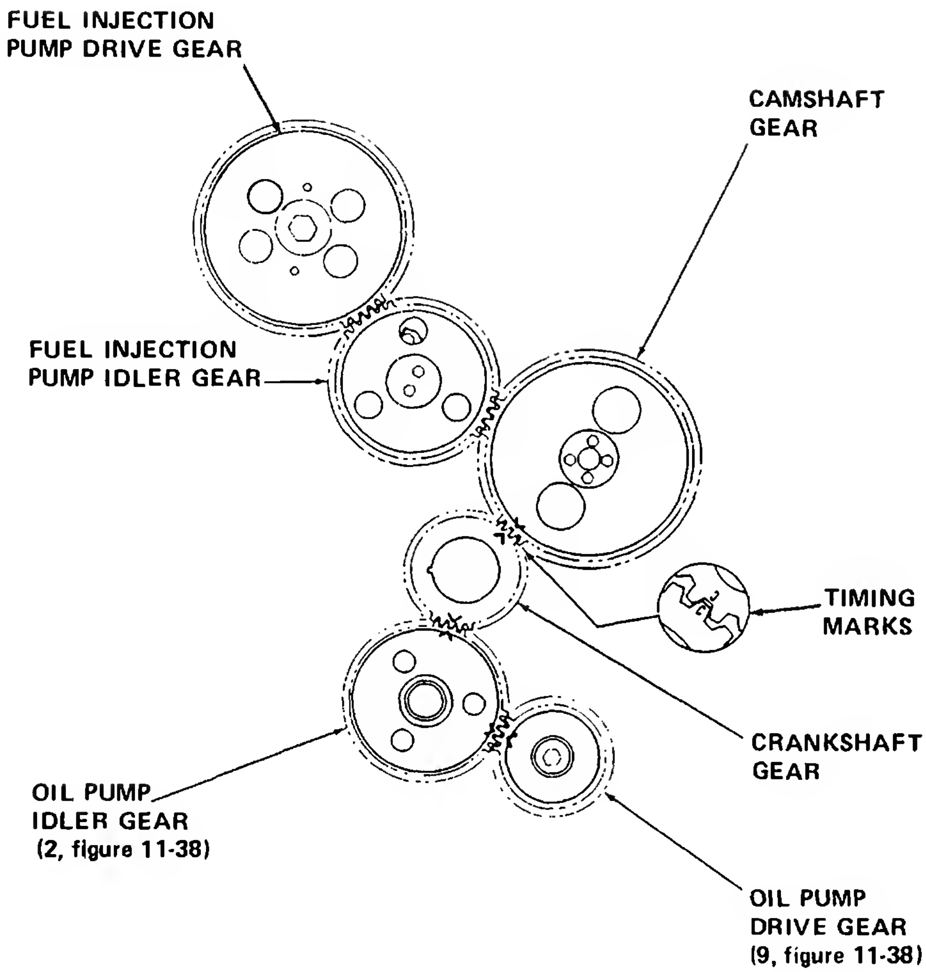
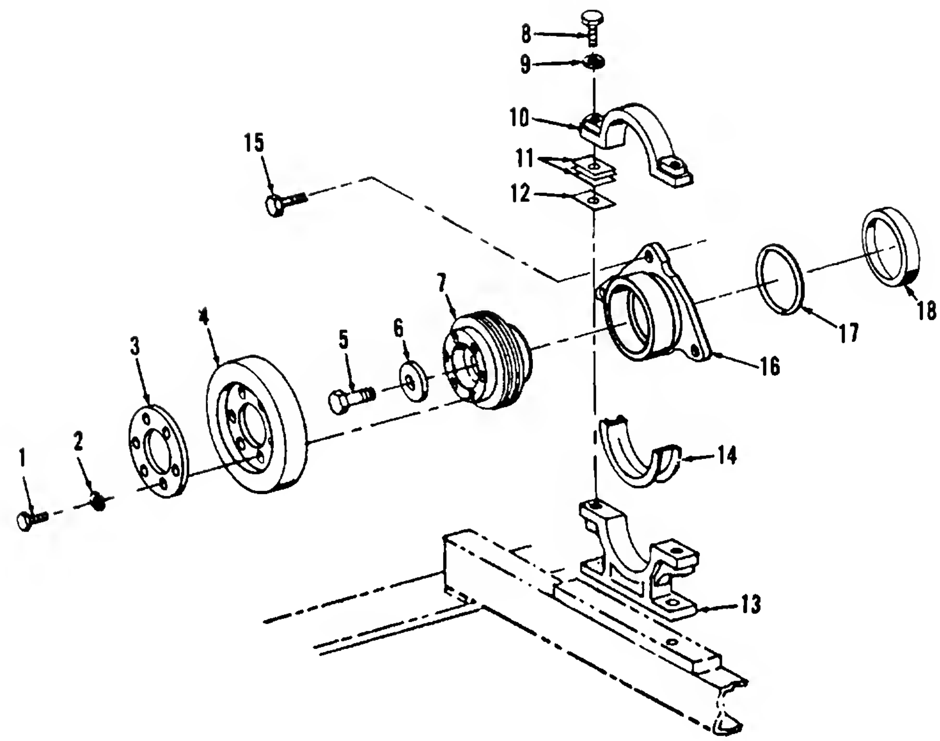


Figure 11-47. Timing Gear, Schematic View



1. BOLT
2. WASHER
3. ADAPTER
4. DAMPER
5. BOLT
6. WASHER
7. CRANKSHAFT PULLEY
8. BOLT
9. WASHER
10. TRUNNION SUPPORT CAP
11. SHIM
12. SHIM
13. TRUNNION SUPPORT BASE
14. BUSHING
15. BOLT
16. TRUNNION
17. SEAL
18. SEAL

Figure 11-48. Crankshaft Pulley, Trunnion, and Trunnion Support, Removal and Installation

(6) Remove bolts (15) to remove trunnion (16).

(7) Remove seals (17 and 18).

NOTE

It is not necessary to remove the fuel injection pump drive gear cover (3, figure 11-49) to remove the timing gear cover (29).

d. If necessary for repair or replacement, remove nuts (1, figure 11-49), washers (2), fuel injection pump drive gear cover (3), and gasket (4). Remove studs (5) only if necessary for repair or replacement.

e. Remove front crankshaft seal (6).

f. Remove wear sleeve (7) using a distorter (see table 2-1).

g. Remove bolts (8), washers (9), and lockwashers (10).

NOTE

Refer to figure 11-35. Bolts (8, figure 11-48), washers (9), and lockwashers (10) are the same as bolts (13, figure 11-35), washers (14), and lockwashers (15).

h. Refer to figure 11-35 and loosen bolts (7 and 10).

i. Refer to figure 11-37 and loosen bolts (1, 3, and 7).

j. Use a lifting device (capable of lifting 3-ton (2.7 t) minimum) raise front of engine, and insert spacers between the cylinder block and the oil pan plate (14, figure 11-37) both sides, to hold plate gasket clear of timing gear housing.

k. Remove bolts (11 and 15, figure 11-49), washers (12 and 16), and covers (13 and 17). Remove and discard gaskets (14 and 18).

l. Remove two bolts from the timing gear cover (29) and install eyebolts in their places.

m. Remove bolts (19), washers (20), and nuts (21).

n. Remove bolts (22, 23, 24, and 25).

o. Remove bolt (26), washer (27), and nut (28).

p. Remove the timing gear cover (29).

q. Remove and discard gasket (30).

11-40. INSPECTION.

a. Using a micrometer and feeler gage, refer to table 1-3 and inspect the fuel injection pump idler gear (8, figure 11-50) for end play.

b. Using a micrometer and feeler gage, refer to table 1-3 and inspect the crankshaft drive gear (19, figure 11-50) for end play.

c. Inspect crankshaft pulley (7, figure 11-48) for worn grooves, cracking, or damage.

d. Check trunnion (16), trunnion support cap (10), and base (13) for flat spots and rough or grooved surfaces.

e. Inspect the timing gear cover (29, figure 11-49) for cracks, and burred or nicked gasket surfaces.

f. Inspect all threaded parts for thread damage.

11-41. REMOVAL OF TIMING GEARS AND PLATE.

a. Refer to paragraph 11-39 to remove the timing gear cover.

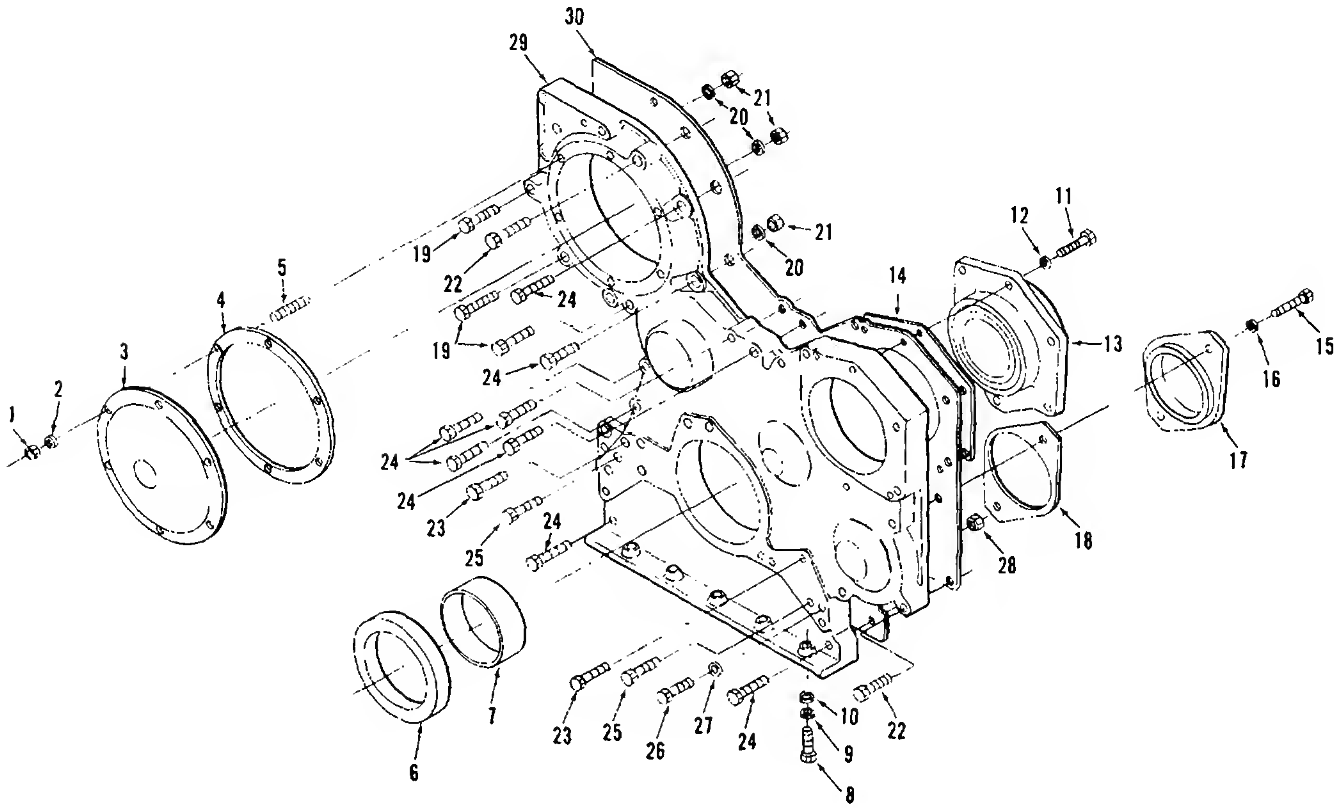
b. Bar the engine manually until all the timing marks are in alignment (see figure 11-47).

c. Refer to Chapter 7 and remove the fuel injection pump.

NOTE

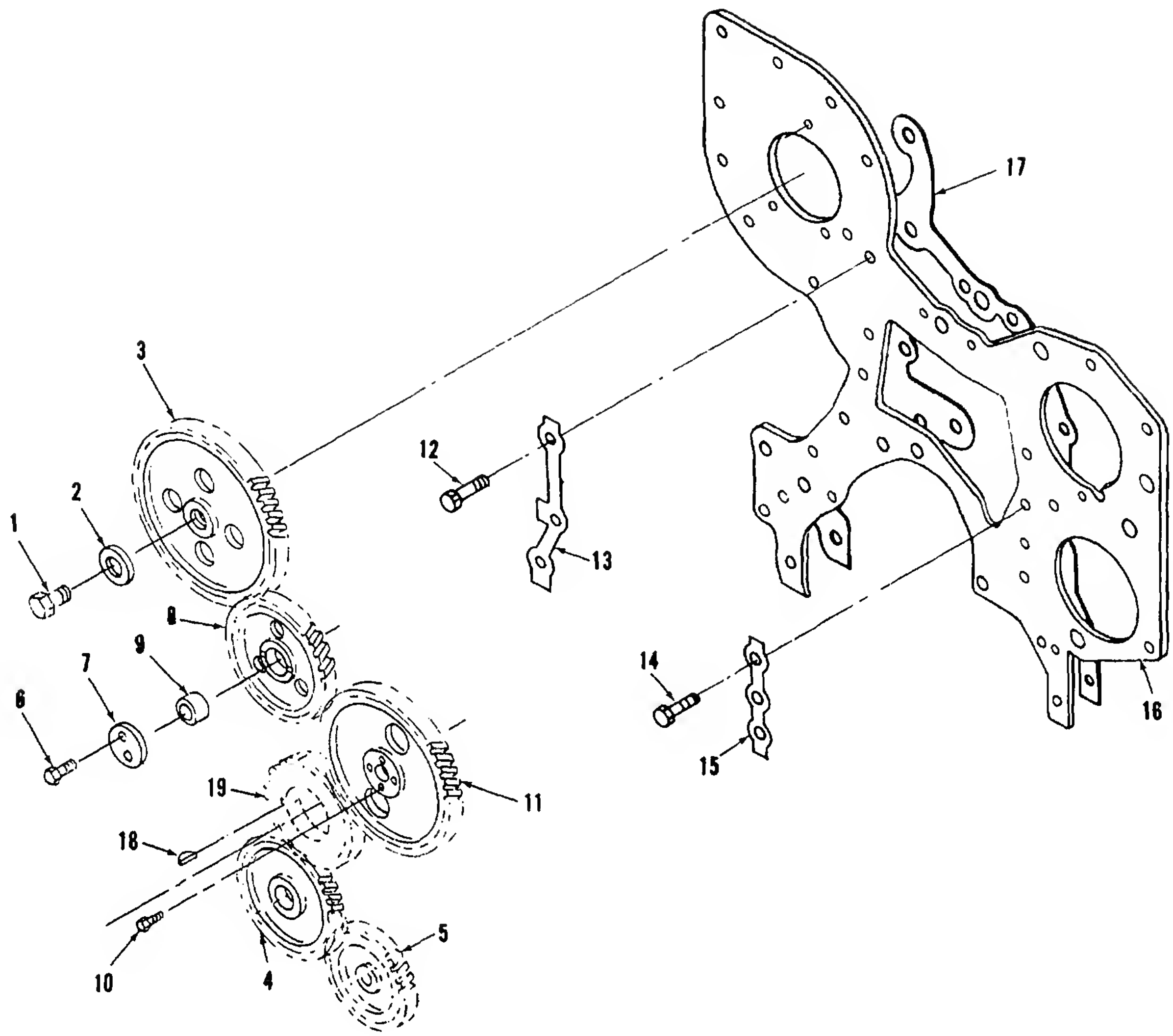
Removal of the fuel injection pump includes the removal of the fuel injection pump drive gear (3, figure 11-50), bolt (1), and washer (2).

NOTE
Torque nuts (1) to 20 ±5 foot-pounds (27 ±7 Newton-meters).
Torque bolts (22) to 17 ±3 foot pounds (23 ±4 Newton-meters).



1. NUT
2. WASHER
3. FUEL INJECTION PUMP DRIVE GEAR COVER
4. GASKET
5. STUD
6. SEAL
7. WEAR SLEEVE
8. BOLT
9. WASHER
10. LOCKWASHER
11. BOLT
12. WASHER
13. COVER
14. GASKET
15. BOLT
16. WASHER
17. COVER
18. GASKET
19. BOLT
20. WASHER
21. NUT
22. BOLT
23. BOLT
24. BOLT
25. BOLT
26. BOLT
27. WASHER
28. NUT
29. TIMING GEAR COVER
30. GASKET

Figure 11-49. Timing Gear Cover, Removal and Installation



1. BOLT
2. WASHER
3. FUEL INJECTION PUMP DRIVE GEAR
4. OIL PUMP IDLER GEAR
5. OIL PUMP DRIVE GEAR
6. BOLT
7. RETAINER
8. FUEL INJECTION PUMP IDLER GEAR
9. BEARING
10. BOLT
11. CAMSHAFT DRIVE GEAR
12. BOLT
13. LOCK
14. BOLT
15. LOCK
16. TIMING GEAR PLATE
17. GASKET
18. WOODRUFF KEY
19. CRANKSHAFT DRIVE GEAR

Figure 11-50. Timing Gears and Plate, Removal and Installation

d. Remove bolts (6) and retainer (7) to remove fuel injection pump idler gear (8).

e. If necessary, remove bearing (9) from idler gear (8).

f. Remove bolts (10) and camshaft drive gear (11).

g. Remove bolts (12 and 14) and locks (13 and 15).

h. Remove timing gear plate (16) and gasket (17).

i. Remove Woodruff key (18).

j. Use a puller to remove crankshaft drive gear (19).

11-42. INSPECTION.

a. Using a micrometer and feeler gage, refer to table 1-3 and inspect the fuel injection pump idler gear bearing (9, figure 11-50) bore width, diameter of shaft, and clearance between bore and shaft.

b. Inspect all gears for worn, nicked, or damaged teeth.

c. Inspect timing gear plate (16, figure 11-50) for cracks and nicked or burred surfaces.

11-43. INSTALLATION OF TIMING GEARS AND PLATE.

a. Insert Woodruff key (18).

b. Heat crankshaft drive gear (19, figure 11-50) to a maximum temperature of 600°F (315°C) and install gear (19) onto crankshaft.

c. Postion gasket (17) and install timing gear plate (16). Install locks (13 and 15) and bolts (12 and 14).

d. Align timing marks and install camshaft drive gear (11). Secure with bolts (10). Refer to figure 11-47.

e. If removed, install bearing (9) into idler gear (8).

f. Install fuel injection pump idler gear (8) and secure with retainer (7) and bolts (6).

g. Refer to paragraph 7-12 and install the fuel injection pump.

11-44. INSTALLATION OF TIMING GEAR COVER.

a. Insert two eyebolts into timing gear cover (29, figure 11-49) to serve as lifting eyes.

b. Position gasket (30) on timing gear cover (29).

c. Position timing gear cover (29) and gasket (30) against the cylinder block.

d. Install nut (28), washer (27), and bolt (26).

e. Install bolts (25, 24, and 23).

f. Install bolt (22). Torque bolt (22) to 17 +/-3 foot-pounds (23 +/-4 Newton-meters).

g. Install nuts (21), washers (20), and bolts (19).

h. Install gaskets (18 and 14) and covers (17 and 13) using bolts (15 and 11) and washers (16 and 12).

i. Remove spacers separating the oil pan plate (14, figure 11-37) from the cylinder block.

j. Install bolts (8, figure 11-49), washers (9), and lockwashers (10).

NOTE

Refer to figure 11-35. Bolts (8, figure 11-49), washers (9), and lockwashers (10) are the same as bolts (13, figure 11-35), lockwashers (14), and washers (15).

k. Refer to figure 11-35 and tighten bolts (7 and 10).

l. Refer to figure 11-37 and tighten bolts (1, 3, and 7).

m. Install seal (17, figure 11-48) on trunnion (16).

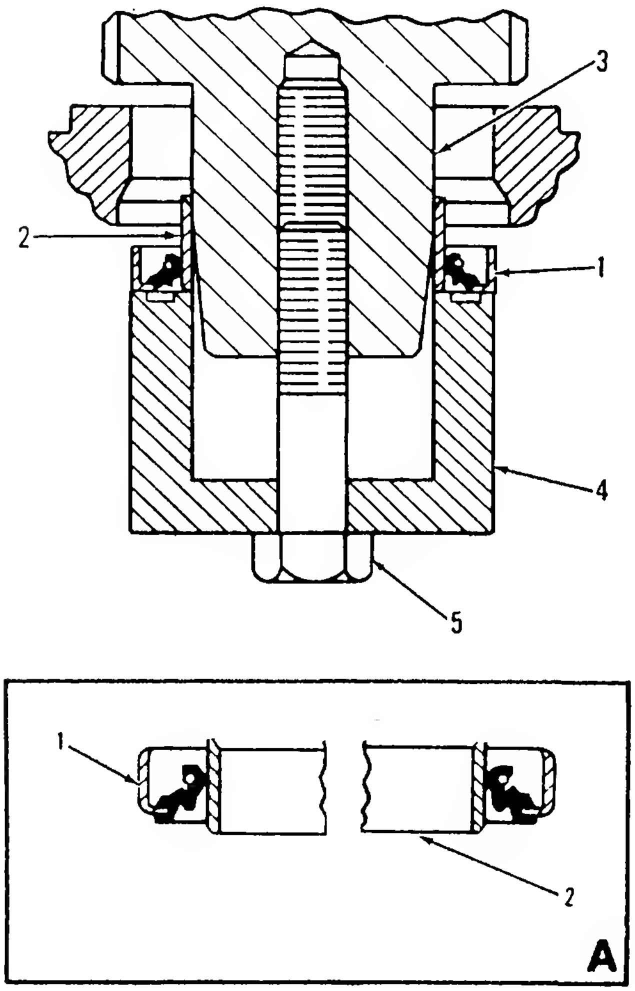
n. Fill slot in trunnion (16) with grease (MIL-G-10924C) and secure trunnion (16) to timing gear cover using bolts (15).

o. Install crankshaft wear sleeve (7) and seal (6, figure 11-49) using an installer (Special Tool 5P7299) and a

bolt (Special Tool 7F8022) (refer to table 2-1 and figure 11-51) as follows:

(1) Lubricate sealing lip of seal (1, figure 11-51) and outside diameter of wear sleeve (2).

(2) Install seal (1) onto sleeve (2) as shown in detail A.



1. SEAL
2. WEAR SLEEVE
3. CRANKSHAFT
4. INSTALLATION TOOL
5. BOLT

Figure 11-51. Installation of Crankshaft Wear Sleeve and Seal

(3) Clean the inside diameter of wear sleeve (2) and outside diameter of the crankshaft (3) with quick cure primer, MIL-P-38336(1).

(4) Coat the inside diameter of wear sleeve (2) and outside diameter of crankshaft (3) with retaining compound, MIL-R-46082A.

NOTE

Ensure that lip of seal (1) is towards the cylinder block and that the outside diameter bevel of the wear sleeve is away from the engine. Put MIL-S-22473 Sealant on the outer metal shell of the seal.

(5) Install wear sleeve (2) and seal (1) onto the crankshaft (3) as shown in figure 11-51.

(6) Attach installing tool (4). Tighten bolt (5) until the inside surface of the installer (4) comes in contact with the crankshaft.

p. If removed during disassembly install studs (5, figure 11-49), fuel injection pump drive gear cover (3), and gasket (4), washers (2) and nuts (1). Torque nuts (1) to 20 +/-5 foot-pounds (27 +/-7 Newton-meters).

q. Install bushing (14), trunnion support base (13), and cap (10) using bolts (8) and washers (9). Use shims (11 and 12) as necessary to maintain a fit of 0.002 loose to 0.003 tight.

r. Install crankshaft pulley (7), washer (6), and bolt (5). Torque bolt (5) to 230 +/-20 foot-pounds (311.9 +/-27.1 Newton-meters). Tap bolt (5) with a hammer, then retorque to 230 +/-20 foot-pounds (311.9 +/-27.1 Newton-meters).

s. Install vibration damper (4), adapter (3), washers (2), and bolts (1).

t. Refer to the Operator and Organizational Maintenance Manual and install the water pump, idler pulley assembly, alternator and fan assembly.

u. Install engine assembly into generator set as instructed in Chapter 2.

Section XI. MAINTENANCE OF CAMSHAFT

11-45. GENERAL. The camshaft is located on the central left portion of the cylinder block, and is driven by the crankshaft gear through the camshaft gear. As the camshaft rotates, cams (raised areas along the shaft which are integral parts of the forging) actuate the valve lifters which move the intake and exhaust valves. This action coordinates the action of the pistons with the movement of the valves.

11-46. REMOVAL OF CAMSHAFT.

a. Remove the timing gear cover in accordance with paragraph 11-39.

b. Remove the valve mechanism and cylinder head in accordance with paragraph 11-10.

c. Turn the camshaft until the timing mark "C" (see figure 11-47) on the camshaft gear aligns with the marking "C" on the crankshaft gear.

d. Place a marking on the fuel injection pump drive gear and idler gear where the teeth mesh. This will indicate their relationship for reassembly.

e. Put a mark on the fuel injection pump idler gear (see figure 11-47) and the camshaft gear at the point where the teeth mesh. This will indicate their relationship for reassembly.

f. Remove valve lifters from block with magnetic extracting tool.

g. Remove bolt (1, figure 11-52), lock (2), and camshaft thrust washer (3).

CAUTION

Use extreme care when removing camshaft from cylinder block to ensure that camshaft bearings are not damaged by cam lobes.

h. Slide camshaft (4) and camshaft gear out of the cylinder block.

i. If necessary, mark camshaft and camshaft gear and refer to paragraph 11-41 to remove camshaft.

11-47. INSPECTION.

a. Using a micrometer and feeler gage, refer to table 1-3 and check camshaft for wear as follows (see figure 11-52):

(1) Check width of groove in camshaft for thrust washer.

(2) Check thickness of thrust washer.

(3) Check camshaft end play.

(4) Check diameter of camshaft bearing surface (journal).

(5) Check height (A) of camshaft cam lobes (see detail A) by measuring diameter of base circle (B) and adding lobe lift (C).

b. Inspect camshaft for cracking or distortion.

c. Using a micrometer and feeler gage, refer to table 1-3 and check the camshaft bearings (see figure 11-53) as follows:

NOTE

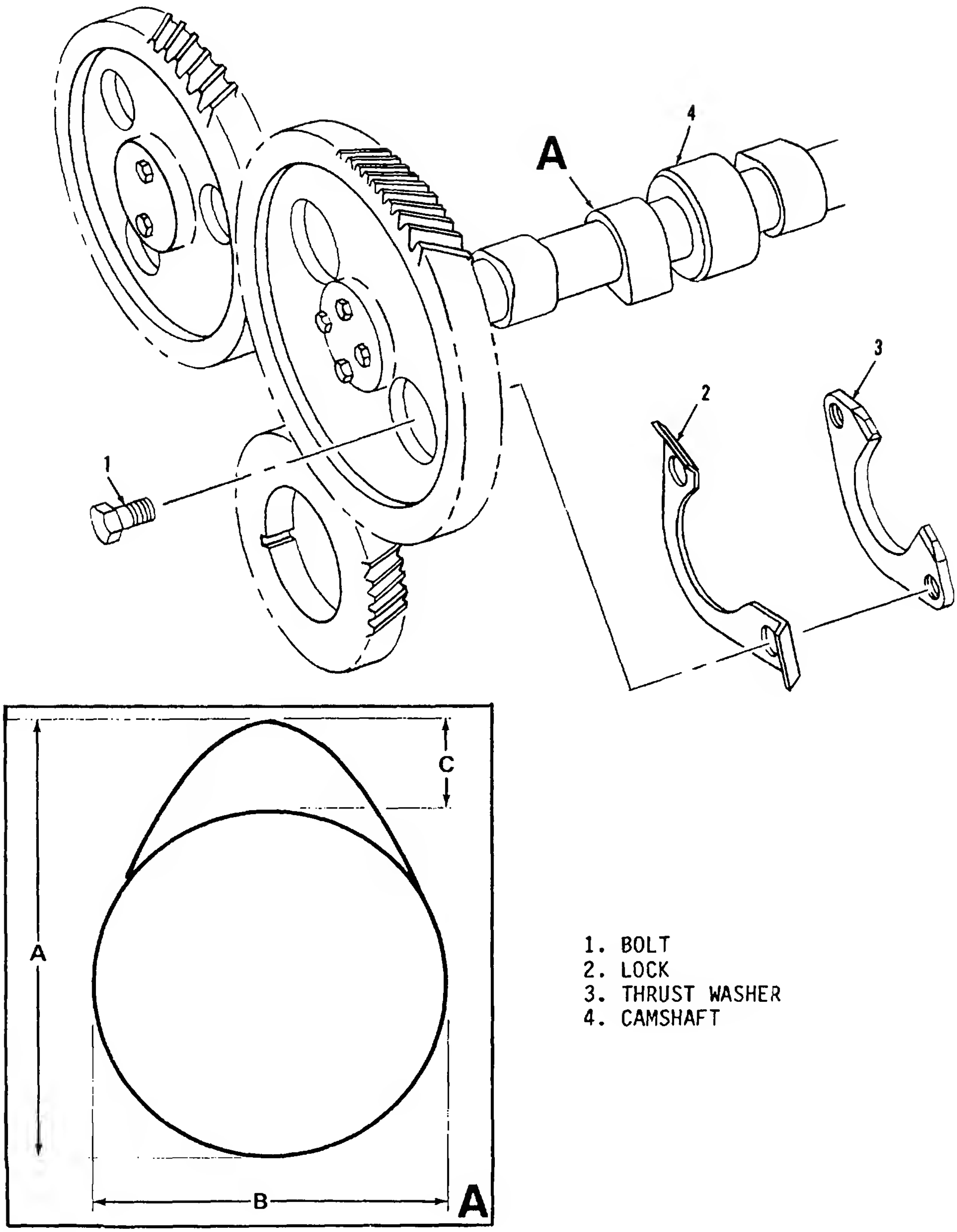
Camshaft bearing clearance can be determined only when bearings are in place.

(1) Check camshaft bearing bore.

(2) Check clearance between camshaft bearing surface and camshaft journal.

11-48. REMOVAL OF CAMSHAFT BEARINGS.

a. Remove camshaft in accordance with paragraph 11-46.



1. BOLT
2. LOCK
3. THRUST WASHER
4. CAMSHAFT

Figure 11-52. Camshaft, Installation and Removal

b. Remove flywheel housing in accordance with paragraph 11-34.

c. Remove camshaft bearings (1 and 2, figure 11-53) using camshaft bearing installation and removal kit (Special Tool 8S2241). Remove front bearing (1) first.

11-49. INSTALLATION OF CAMSHAFT BEARINGS.

NOTE

The front and rear camshaft bearings must be recessed 0.06 +/-0.02 inches (1.5 +/-0.5 mm) from their faces of the cylinder block.

a. Use a tool to install camshaft bearings (1 and 2, figure 11-53) using camshaft bearing installation and removal kit (Special Tool 8S2241). Front and rear bearings must be recessed 0.06 +/-0.02 inches (1.5 +/-0.5 mm) from their respective faces of the cylinder block. Install all bearings so that oil holes in bearings are in alignment with the oil holes in the cylinder block.

b. Install flywheel housing in accordance with paragraph 11-37.

c. Install camshaft in accordance with paragraph 11-50.

11-50. INSTALLATION OF CAMSHAFT.

a. If removed, align camshaft and camshaft gear and assemble.

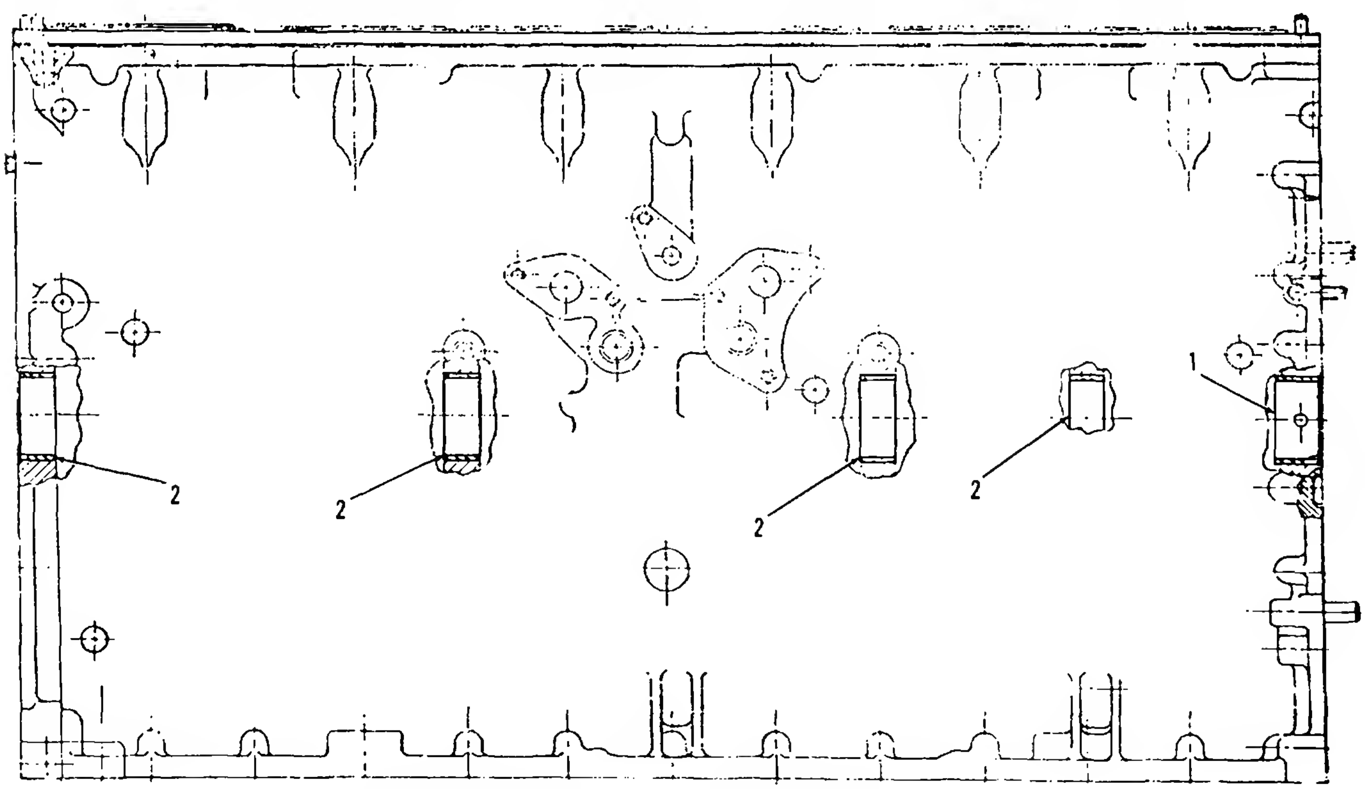
b. Lubricate cam lobes and bearing journals of the camshaft with clean engine oil.

c. Install camshaft (4, figure 11-52) so that timing marks on camshaft gear, crankshaft gear, fuel injection pump idler gear, and fuel injection pump drive gear are all in alignment.

d. Install camshaft thrust washer (3) and lock (2). Secure with bolts (1).

e. Install cylinder head and valve mechanism in accordance with paragraph 11-15.

f. Install timing gear cover in accordance with paragraph 11-44.



1. FRONT BEARING 2. BEARING

Figure 11-53. Camshaft Bearings, Removal and Installation

Section XII. MAINTENANCE OF CRANKSHAFT MAIN BEARINGS

11-51. GENERAL. The crankshaft and main bearings are located in the heart of the cylinder block, directly beneath the cylinders. The vertical movement of the pistons within the cylinders is transmitted through the connecting rods to the crankshaft. The crankshaft is designed so the action of the connecting rods and crankshaft converts the vertical movement of the pistons into rotary motion. Counterweights are forged integrally with the crankshaft and drilled to obtain proper shaft balance. The main bearings and caps support the crankshaft in the cylinder block. Raised tabs on the outside of each bearing half fit into recesses in the cylinder block and bearing cap, securing the bearing and preventing it from rotating. The rotary motion of the crankshaft is transmitted through the crankshaft gear and crankshaft pulley at the front of the engine, and through the flywheel at the rear.

11-52. REMOVAL.

a. Refer to paragraph 11-26 and remove the connecting rods and pistons.

b. Refer to paragraph 11-34 and remove the flywheel assembly.

c. Refer to paragraph 11-39 and remove the timing gear cover.

d. Put the engine block into an engine stand which allows easy acess to the underside of the block.

e. Turn the crankshaft until the "C" timing mark on the crankshaft aligns with the "C" timing mark on the camshaft gear (see figure 11-47).

NOTE

Weight of crankshaft is 208 pounds (95 kg).

f. Attach a hoist (capable of lifting 1/2-ton (454 kg) minimum) equipped with two web-type slings to the crankshaft.

g. Remove bolts (1, figure 11-54), washers (2), and main bearing caps (3). Remove lower bearing halves (4).

h. Remove crankshaft assembly (5).

i. Remove upper bearing halves (4) from cylinder block.

j. Remove thrust bearings (6).

k. Remove crankshaft plug (7) to inspect oil passages for obstructions.

11-53. INSPECTION.

a. Inspect bearing surfaces for scoring, flaring, chipping, and cracks.

b. Inspect main bearing caps for high spots and burrs.

c. Inspect for damaged threads.

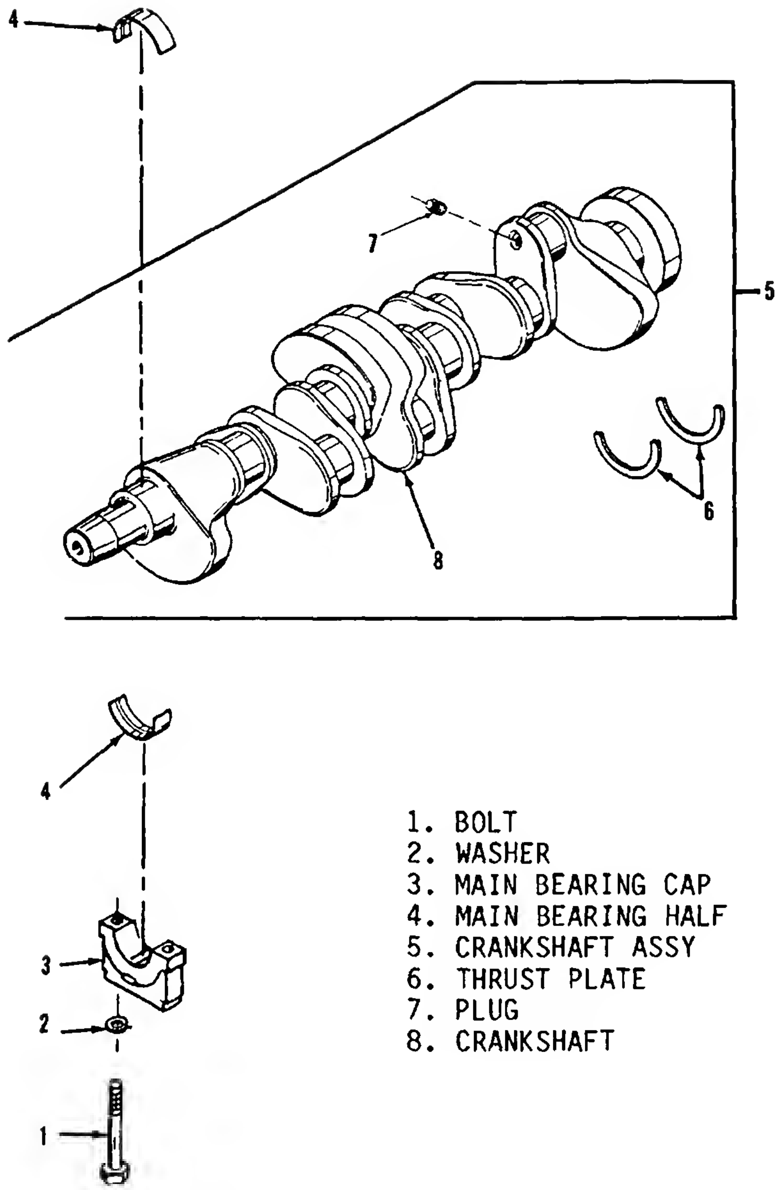
d. Refer to table 1-3 and check bearing to crankshaft clearance as follows:

(1) Position crankshaft (8) and upper bearing halves (4) in cylinder block.

(2) Place a small strip of plastic (per Military Specification L-P-525A) between lower bearing half (4, figure 11-54) and crankshaft. Light grease will hold the plastic strip in position.

(3) Lubricate bolts (1) and washers (2) with clean engine oil. Install main bearing halves (4), caps (3), washers (2) and bolts (1). Torque bolts to 30 +/-3 foot-pounds (40.7 +/-4 Newton-meters). Mark both bolts and each cap, and tighten an additional 90 degrees.

(4) Remove bearing caps (3) and bearing halves (4) and measure thickness of plastic strip (main bearing clearance) with micrometer.



1. BOLT
2. WASHER
3. MAIN BEARING CAP
4. MAIN BEARING HALF
5. CRANKSHAFT ASSY
6. THRUST PLATE
7. PLUG
8. CRANKSHAFT

Figure 11-54. Crankshaft and Main Bearings, Removal and Installation

e. Inspect thrust washer contact area at rear of crankshaft, on either side of rear main crankshaft bearing journal, for excessive wear or roughness.

f. Inspect machined surface, at rear of crankshaft, that comes into contact with rear oil seal for a grooved condition.

g. Inspect crankshaft for scoring or galling on crankpin and main journals.

h. Refer to table 1-3 and, using a micrometer, inspect thrust plates (6) for excessive wear, distortion, and discoloration.

11-54. INSTALLATION.

a. Install plug (7) and torque to 17 +/-3 foot-pounds (23 +/-4 Newton-meters). Stake the plug.

b. Be sure bearing supports in block and upper bearing halves (4) are clean and dry then install bearing halves into cylinder block.

c. If crankshaft gear was removed, ensure that gear and shaft are properly aligned and install crankshaft gear in accordance with paragraph 11-43.

d. Lubricate upper bearing halves (4).

NOTE

Do not install thrust plates (6) with steel back against the crankshaft.

e. Install thrust plates (6) with side identified "BLOCK SIDE" towards the cylinder block. The plates have a tab which fits into a machined area in the cylinder block. The tab will not allow the thrust plate to be installed backwards with the steel back against the crankshaft.

f. Using a hoist (capable of lifting 1/2-ton (454 kg) minimum), position the crankshaft in the cylinder block. Ensure that all timing marks are in alignment.

g. Be sure bearing caps (3) and lower bearing halves (4) are clean and dry then insert bearing halves into bearing caps.

h. Lubricate the bolts (1) and washers (2) with clean engine oil.

i. Position caps (3) in their proper postion with the number on each cap in alignment with the number on the pan face on the left side of the engine block.

j. Secure caps (3) with bolts (1) and washers (2). Torque bolts to 30 +/-3 foot-pounds (40.7 +/-4 Newton-meters). Mark both bolt heads and each cap. Tighten bolts an additional 90 degrees from mark.

k. Install the timing gear cover in accordance with paragraph 11-44.

l. Install the flywheel assembly in accordance with paragraph 11-37.

m. Install the connecting rods and pistons in accordance with paragraph 11-28.

Section XIII. MAINTENANCE OF THE CYLINDER BLOCK

11-55. GENERAL. The cylinder block is cast as one piece, and forms the structural heart of the engine. The cast block accepts cylinder liners, which insulate and reinforce the block. The spacer plate eliminates counterbores normally used on the top face of the cylinder block and results in a stronger block. Coolant and lubricating oil circulate through passages in the casting. The flywheel housing attaches to the rear of the cylinder block. The timing gear cover and plate, and the water pump, attach to the front of the block. The oil pan, oil pump and plate attach to the bottom of the cylinder block. The spacer plate and cylinder head are mounted on top of the block.

11-56. REMOVAL.

a. Remove the cylinder head assembly in accordance with paragraph 11-10.

b. Refer to the Operator and Organizational Maintenance Manual and remove the fan assembly and idler pulley assembly.

c. Remove the connecting rods and pistons in accordance with paragraph 11-26.

d. Remove the cylinder liner sleeves in accordance with paragraph 11-30.

e. Remove the flywheel assembly in accordance with paragraph 11-34.

f. Remove the timing gears and plate in accordance with paragraph 11-41.

g. Remove the camshaft and bearings in accordance with paragraphs 11-46 and 11-48.

h. Remove the crankshaft and main bearings in accordance with paragraph 11-52.

i. Remove the fuel filter in accordance with Chapter 7.

j. Refer to the Operator and Organizational Manual and remove the oil filter, oil cooler, turbocharger, and exhaust manifold.

k. Remove bolts (1, figure 11-55) and washers (2) to remove filler neck (3) and gasket (4).

l. Remove orifices (5) from cylinder block.

m. Remove dowels (6, 7, and 8).

n. Remove studs (9).

o. Remove dowel (10) and seal (11). Discard seal (11).

11-57. INSPECTION.

a. Refer to table 1-3 and, using a micrometer and feeler gage, inspect the cylinder block main bearing bore, camshaft bearing bore, dimension from center of main bearing bore to top of cylinder block, and dimensions from center of main bearing bore to bottom of block.

b. Inspect cylinder bore for out-of-round condition, distortion, cracking, pitting, erosion, or other defects.

c. Inspect top of cylinder block for grooving or roughness. Check top of block for flatness using an accurate straight edge and feeler gage.

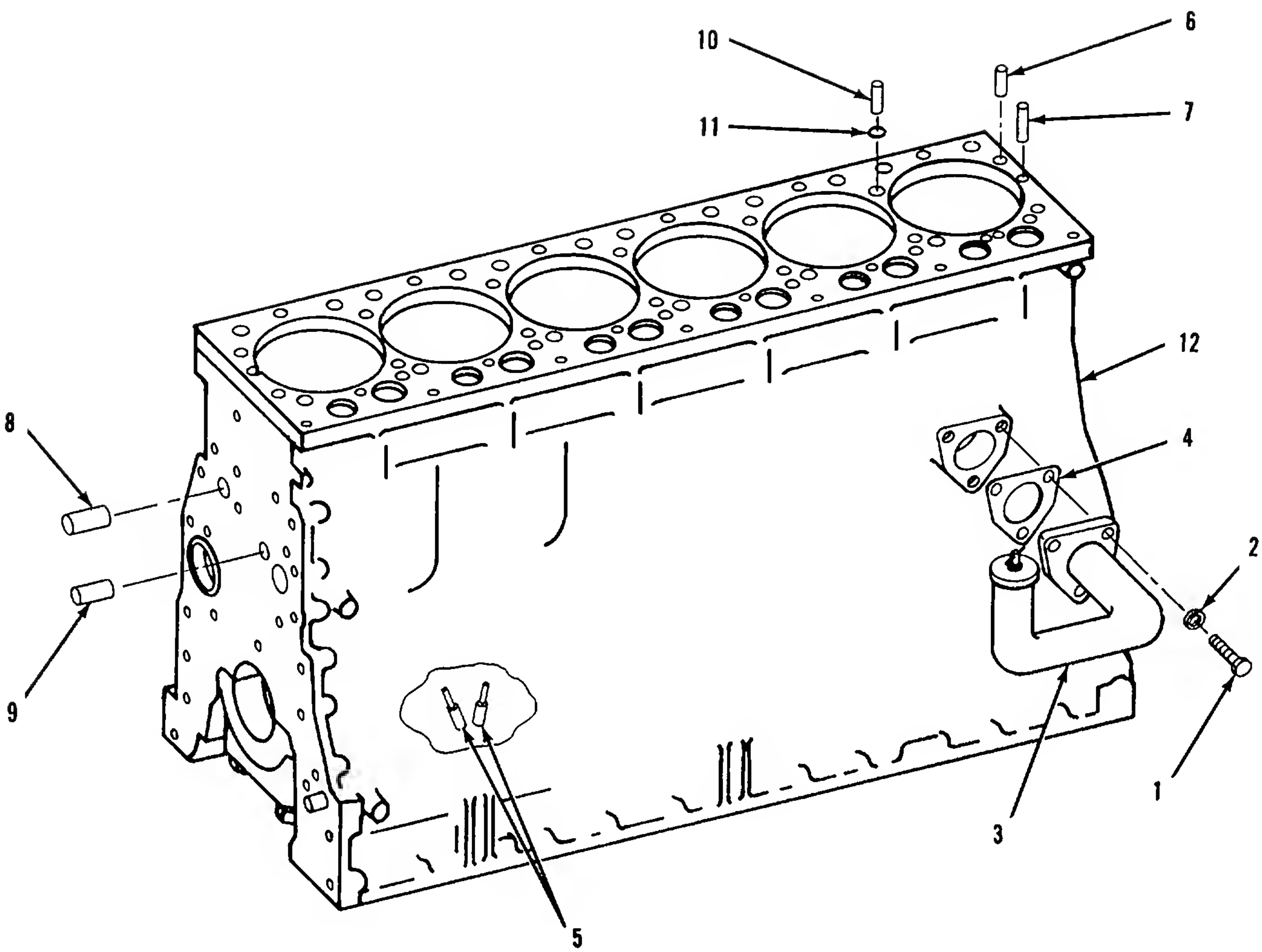
d. Use dye penetrant to check for cracks as follows:

(1) Clean suspected area thoroughly.

(2) Apply dye penetrant (MIL-P-47158) and allow time for dye to dissolve or enter crack or defect. Do not "force" dry.

(3) Remove excess dye and apply developer so that defect will stand out.

(4) Cracks usually show up as a solid or dotted line. This can also indicate a nondamaging forging lap and should be double checked before



1.	BOLT	7.	DOWEL
2.	WASHER	8.	DOWEL
3.	FILLER NECK	9.	STUD
4.	GASKET	10.	DOWEL
5.	ORIFICE	11.	SEAL
6.	DOWEL	12.	CYLINDER BLOCK

Figure 11-55. Cylinder Block, Exploded View

replacing block. Porosity shows up as a dotted area.

e. Use a magnetic crack detector to check dye penetrant indications of cracking.

f. Inspect all threaded holes for thread damage.

g. Inspect dowels (6, 7, 8, and 10) for damage or defect.

h. Inspect stud (9) for damage or defect.

i. Inspect orifices (5) for evidence of clogging and particles of dirt or metal.

11-58. REPAIR.

a. Repair minor thread damage using a thread chaser.

b. Clean all oil passages in the block with a brush or rod, and use compressed air to clean all passages.

c. Clean all orifices (5) using a brush, and clean with compressed air.

d. Repair damaged or defective dowels (6, 7, 8, and 10, figure 11-55) by replacement.

e. Repair damaged or defective stud (9) by replacement.

CAUTION

Do not use a disc sander to resurface cylinder block. Do not allow sander to tilt or rock since this may result in damage to the block.

CAUTION

When a cylinder block has been resurfaced, critical dimensions such as valves must be checked and corrected. The pushrods must also be adjusted to prevent the valves from striking the piston during operation.

f. Resurface cylinder block if it is scratched, etched, or worn unevenly. Use an orbital sander to sand cylinder block. Do not use in disc sander. Do not allow sander to tilt or rock, since this may result in damage to the surface or edges of the block. Do not remove more than 0.002 inch (0.050 mm) metal in total from the surface of the cylinder block. Stamp the amount of stock removed on an area not used as a sealing face.

11-59. REBUILD/OVERHAUL.

a. Remove rust and scale from cylinder block using a stiff brush. Treat and repaint in accordance with MIL-T-704, Type A, forest green color.

b. Use counterboring tool arrangement to adjust cylinder liner projection above cylinder block as follows:

(1) Determine cylinder height projection in accordance with paragraph 11-31.

(2) Install counterboring tool on cylinder block.

(3) Counterbore block a minimum of 0.007 inch (0.178 mm). The maximum allowable counterbore depth is 0.030 inch (0.76 mm).

NOTE

Ensure that the 0.007 inch (0.178 mm) shim is inserted directly under the cylinder liner flange.

(4) Install 0.007 inch (0.178 mm) shim or any shim necessary to obtain the correct cylinder liner projection. Refer to table 1-3 for correct cylinder liner projection and specifications of shims.

c. Replace orifices (5).

d. Replace all dowels (6, 7, 8, and 10).

e. Replace studs (9).

f. Replace filler neck gasket (4).

11-60. INSTALLATION.

NOTE

Do not service cooling or lubricating oil systems until reassembly is completed.

a. Install new seal (11, figure 11-55) and dowel (10).

b. Install stud (9).

c. Install dowels (6, 7, and 8).

d. Install orifices (5).

e. Install filler neck (3) and gasket (4) using bolts (1) and washer (2).

f. Install crankshaft and main bearings in accordance with paragraph 11-54.

g. Install camshaft and bearings in accordance with paragraphs 11-49 and 11-50.

h. Install the timing gears and plate in accordance with paragraph 11-43. Install timing gear cover in accordance with paragraph 11-44.

i. Install the flywheel assembly in accordance with paragraph 11-37.

j. Install the cylinder liner sleeves in accordance with paragraph 11-32.

k. Install the connecting rods and pistons in accordance with paragraph 11-28. This includes the installation of cylinder head assembly (paragraph 11-15) and installation of the engine assembly into the generator set.

l. Refer to the Operator and Organizational Maintenance Manual and install the exhaust manifold, turbocharger, oil cooler, oil filter, idler pulley assembly, and fan assembly.

m. Service cooling and lubricating oil systems in accordance with the Operator and Organizational Maintenance Manual.

CHAPTER 12

MAINTENANCE OF SUPPORT SYSTEM

12-1. GENERAL. The skid base is a welded structure that supports the generator set. The engine, generator, and fuel tank are mounted on the base. The engine front support and generator mounting provide a three-point support system for the engine and generator. The battery and rollout tray are mounted in the front end of the base and the tool box in the rear end. A tubular crossmember at each end of the base permits connection of a towing device for skidding the set, for short distance moving. Forklift openings in the base allow the generator set to be forklifted. The base is equipped with a split-stud grounding terminal.

12-2. REPAIR Refer to figure 12-1.

a. Removal. Remove the skid base as follows:

(1) Refer to Operator and Organizational Maintenance Manual and perform the following:

(a) Drain coolant from radiator.

(b) Drain fuel from day and fuel tanks.

(c) Drain lubricating oil from engine crankcase.

(d) Disconnect batteries.

(e) Remove housing, tool box, and filler panels.

(f) Remove lifting frame.

(2) Remove winterization kit (if required) as described in Chapter 13.

(3) Remove generator as specified in Chapter 2.

(4) Remove engine as specified in Chapter 2.

(5) Remove screws (31) and nuts (32), and rear tank stops (30).

(6) Remove fuel tank as specified in paragraph 7-5

(7) Remove batteries (4) from rollout tray (20) by removing nuts (1), washers (2), and retainers (3). Slide tray partially out of skid base.

(8) Remove screws (12) and washers (2) and remove stop bracket (11). Slide tray out of skid base.

b. Disassembly. Refer to figure 12-1 and disassemble skid base.

(1) Disassemble battery tray as follows:

(a) Remove studs (7) and quick release pins (10).

(b) Remove left and right runners (15 and 16) by removing screws (13) and lockwashers (6).

(c) Remove washers (2) and cotter pins (17) and slide shaft (18) out of rollout tray (20). Remove roller (19).

(2) Remove ground rod plate (24) by removing screw (25), washer (26), and nut (27)

(3) Remove grounding stud, washers, and nut.

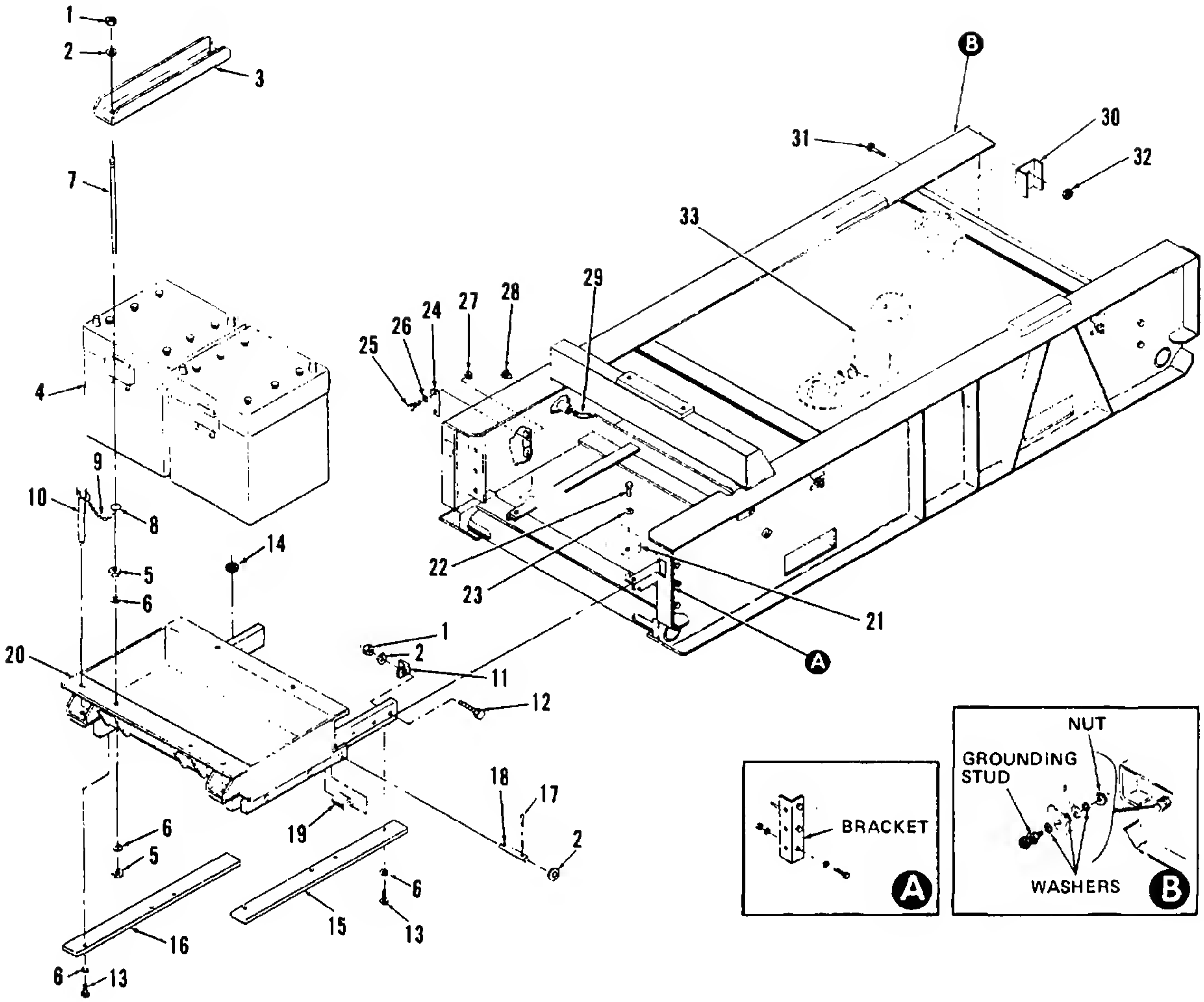
(4) Remove plug (28) and elbow (29).

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

c. Cleaning.

(1) Clean skid base and battery tray with cleaning solvent, P-D-680, Type II, and dry thoroughly.



1. NUT	12. SCREW	23. WASHER
2. WASHER	13. SCREW	24. GROUND ROD PLATE
3. RETAINER	14. BALL	25. SCREW
4. BATTERY	15. LEFT RUNNER	26. WASHER
5. NUT	16. RIGHT RUNNER	27. NUT
6. LOCKWASHER	17. COTTER PIN	28. PLUG
7. STUD	18. SHAFT	29. ELBOW
8. HOOK	19. ROLLER	30. REAR TANK STOP
9. CHAIN	20. ROLLOUT TRAY	31. SCREW
10. QUICK RELEASE PIN	21. STOP ANGLE	32. NUT
11. STOP BRACKET	22. SCREW	33. FILLER NECK

Figure 12-1. Skid Base, Exploded View

If necessary, remove caked deposits with a bristle brush.

(2) Clean sealant from pipe threads using a wire brush.

d. Inspection.

(1) Inspect for cracks, breaks, and defective welds.

(2) Inspect threads for damage.

(3) Inspect battery tray for damage and corrosion.

(4) Inspect support brackets for distortion.

WARNING

Welding operations produce heat, highly toxic fumes, injuruious radiation, metal slag, and airborne particles Welding goggles, the proper tinted lenses, apron or jacket, and welder's boots are required.

e. Repair.

(1) Weld cracks, breaks, and defective welds.

(2) Repair damaged threads with a suitable die or tap.

(3) Straighten distorted support brackets

WARNING

Paint is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

(4) Scrape off damaged paint. Blend in edges, prime, and paint damaged areas using olive drab per MIL-T-704, Type A, and semi-gloss, No. X24087.

f. Assembly. Assemble skid base as follows:

(1) Assemble rollout tray (20) as follows·

(a) Position rollers (19) in track and install shaft (18). Secure with cotter pins (17) and washers (2)

(b) Install left and right runners (15 and 16) with screws (13) and lockwashers (6).

(c) Install two stops (11) on track. Secure each stop with screw (12), lockwasher (2), and nut (1).

(d) Install tray (20) on base. Align quick release pin holes on tray with holes on skid base by adjusting each stop bracket (11) until it hits the crossmember angle on the base. Then tighten nut that secures stop bracket. Install quick-release pins (10).

(e) Install front stop angle on base and secure with screws and nuts.

(2) Install grounding stud and secure with washers and nut.

(3) Install ground rod plate (24) and secure with screw (25), washer (26), and nut (27).

(4) Install two rear tank stops (30) and secure with screws (31) and nuts (32).

(5) Install plug (28) and elbow (29).

g. Installation.

(1) Install fuel tank as specified in paragraph 7-5.

(2) Refer to the Operator and Organizational Maintenance Manual and install housing components and tool box.

(3) Install engine as specified in Chapter 2.

(4) Install generator as specified in Chapter 2.

(5) Refer to the Operator and Organizational Maintenance Manual and install lifting frame.

(6) Install winterizatioon kit (if required) as described in Chapter 13.

CHAPTER 13

MATERIEL USED IN CONJUNCTION WITH MAJOR ITEM

Section I. FUEL BURNING WINTERIZATION KIT

13-1. GENERAL. The fuel burning winterization kit preheats the engine coolant and lubricating oil for ease of generator starting in ambient temperatures down to -65°F (-53.9°C). The kit is integrally mounted in the generator set and consists of a 24-volt, fuel-fired coolant heater with integral coolant pump, control box, thermostat switch, manual shutoff valves, wiring, lines, and fittings. Heated coolant is circulated through the engine cooling system and oil pan heat exchanger by the heater coolant pump. Automatic heater cycling is controlled by the thermostat switch to prevent excessive coolant temperature. The heater is designed to operate on the same fuels as the generator set engine. The heater is mounted in the right engine compartment.

13-2. TROUBLESHOOTING. This section contains troubleshooting information (refer to table 13-1) for locating and correcting the operating troubles which may develop in the fuel burning winterization kit. Each malfunction for an individual component, unit, or system is followed by a list of tests or inspections which will help you to determine the probable cause and corrective actions in the order listed.

13-3. HEATER ASSEMBLY. The heater is a fuel burning type designed to preheat the engine for starting at low temperatures down to -65°F (-53.9°C) by circulating heated coolant through the engine. The heater consists of a blower motor, fuel regulator valve, limit switch, igniter, flame switch, and a coolant pump. The blower motor and fan assembly provides air for combustion; it is also a means for driving the coolant pump. The fuel regulator valve permits the fuel to be turned on and off; it also regulates the fuel flow to the burner. The igniter, which is a high-resistance glow plug is used to vaporize and ignite the fuel. The flame switch controls the electrical supply to the igniter, blower motor, and indicator lamp; its operation is determined by temperature. Recirculation of heated coolant is provided by the coolant pump at a rate of 80 to 100 gph (302 to 378 liters per hour). Coolant is circulated around the heater combustion chamber where it is heated and then circulated through the engine. The following paragraphs provide replacement, inspection, test, and repair procedures for the heater assembly and its major components.

a. Removal and Replacement. To replace the heater assembly (45, figure 13-1) proceed as follows:

WARNING

Disconnect the negative cable of either battery.

(1) Close valves (15 and 27). Place a suitable container under COOLANT DRAIN at outside of skid base. Then open valve (32) and drain coolant.

(2) Remove cover from burner and disconnect plug P28 from heater assembly (45).

(3) Disconnect hose assembly (17) from elbow (10), then remove elbow (10).

(4) Disconnect hose assembly (25) from connector (22). Remove

Table 13-1. Fuel Burning Winterization Kit, Troubleshooting

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

1. CONTROL BOX ON-OFF SWITCH POSITIONED TO ON BUT HEATER DOES NOT OPERATE.

Step 1. Test limit switch (refer to the Operator and Organizational Maintenance Manual).

Replace defective limit switch (refer to paragraph 13-3).

Step 2. Test flame switch (refer to the Operator and Organizational Maintenance Manual).

Replace defective flame switch (refer to paragraph 13-3).

2. HEATER STARTS BUT WILL NOT IGNITE.

Step 1. Check for clogged orifice.

Clean orifice. Replace if defective (refer to paragraph 13-3).

Step 2. Inspect and test regulator valve assembly (refer to paragraph 13-3).

Replace regulator valve assembly (refer to paragraph 13-3).

3. FAN RUNS CONTINUOUSLY WITH SWITCH OFF.

Step 1. Check for broken quartz rod (refer to paragraph 13-3).

Replace quartz rod (refer to paragraph 13-3).

Step 2. Inspect and test flame switch (refer to paragraph 13-3 and the Operator and Organizational Maintenance).

Adjust or replace flame switch (refer to paragraph 13-3 and the Operator and Organizational Maintenance Manual).

4. HEATER STARTS, THEN SHUTS OFF

Step 1. Test microswitch (refer to the Operator and Organizational Maintenance Manual).

Replace defective microswitch (refer to paragraph 13-3).

Table 13-1. Fuel Burning Winterization Kit, Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

4. HEATER STARTS, THEN SHUTS OFF (Continued)

Step 2. Inspect, test, and adjust regulator valve assembly (refer to paragraph 13-3).

Replace defective regulator valve assembly (refer to paragraph 13-3).

5. CIRCUIT BREAKER TRIPS OPEN.

Check for short circuits.

Test control box components (refer to paragraph 13-5) and check wiring harnesses.

6. HEATER WILL NOT SHUT OFF.

Step 1. Test fuel regulator valve (refer to paragraph 13-3). It may be stuck open.

Replace defective fuel regulator valve (refer to paragraph 13-3).

Step 2. Inspect and test flame switch (refer to paragraph 13-3 and the Operator and Organizational Maintenance Manual).

Replace defective flame switch (refer to paragraph 13-3).

7. HEATER COMBUSTION SURGES.

Test fuel regulator valve (refer to paragraph 13-3).

Replace defective fuel regulator valve (refer to paragraph 13-3).

8. COOLANT PUMP FAILS TO CIRCULATE COOLANT.

Test coolant pump and motor assembly (refer to paragraph 13-3).

Replace defective coolant pump and motor assembly (refer to paragraph 13-3).

Table 13-1. Fuel Burning Winterization Kit, Troubleshooting (Continued)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

9. COOLANT PUMP TURNS OVER BUT FAILS TO DELIVER LIQUID.

Inspect coolant pump and motor for clogged passages (refer to paragraph 13-3).

Disassemble and clean pump (refer to paragraph 13-3).

10. HEATER OPERATES ERRATICALLY OR AT REDUCED OUTPUT.

Step 1. Check voltage input to motor. It should be 24 V dc.

Replace defective wiring harnesses (refer to the Operator and Organizational Maintenance Manual).

Step 2. Inspect motor brushes for wear.

Replace defective brushes.

Step 3. Inspect pump cam ring bore (refer to paragraph 13-3).

Replace defective cam ring (refer to paragraph 13-3).

Step 4. Inspect pump for foreign matter in blade slot.

Remove, disassemble and clean pump (refer to paragraph 13-3).

11. HEATER LEAKS.

Inspect face of cage and seal assembly for scoring or other damage (refer to paragraph 13-3).

Replace or refinish cage and seal assembly (refer to paragraph 13-3).

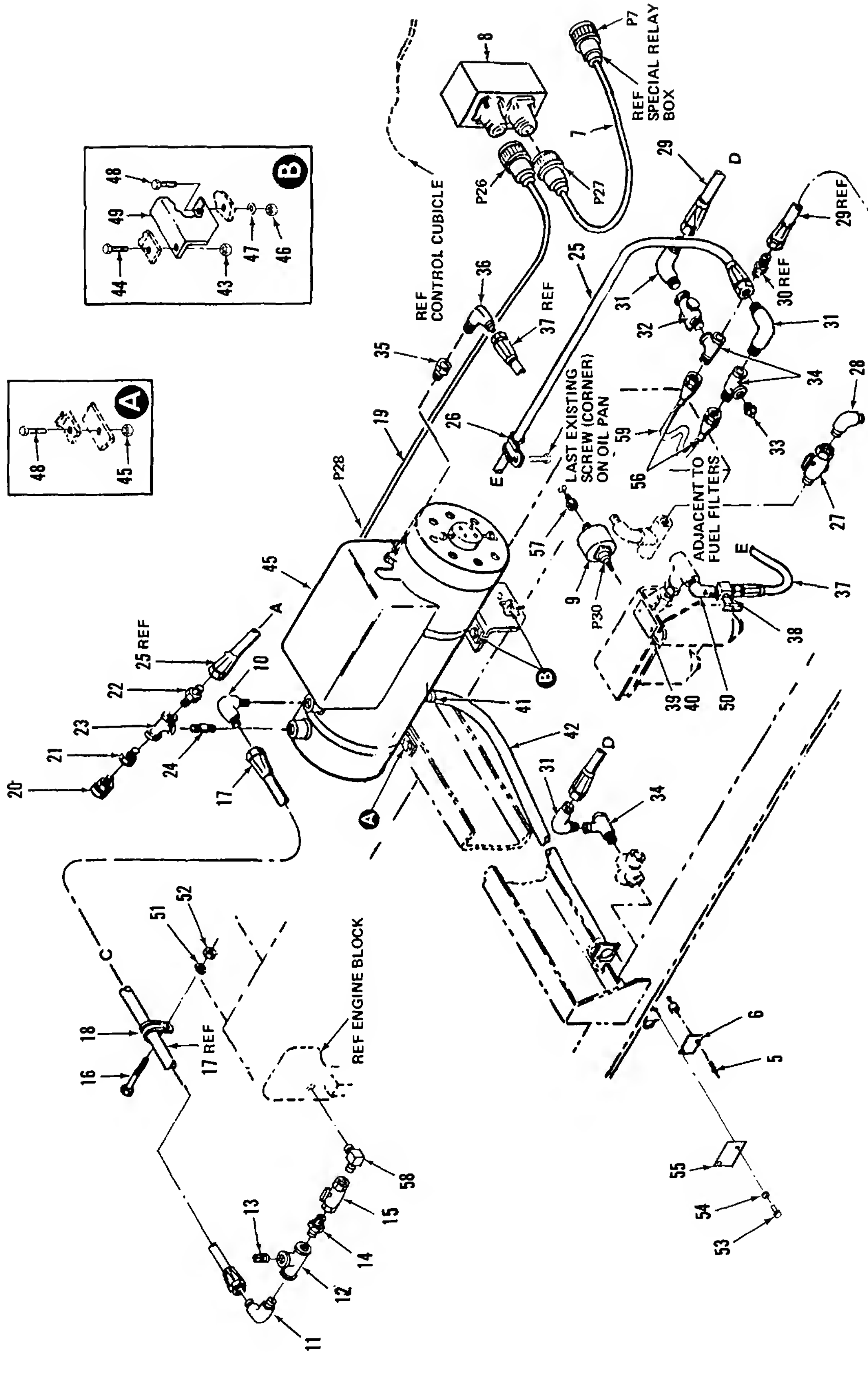
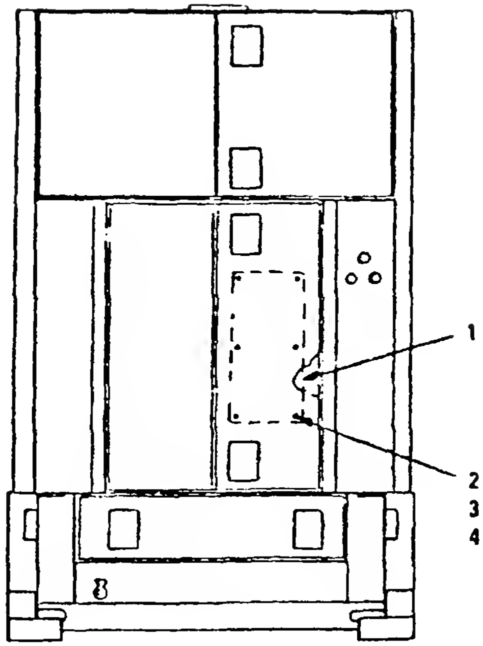


Figure 13-1. Fuel Burning Winterization Kit (Sheet 1 of 2)



REAR VIEW OF GENERATOR SET

1. SYSTEM DIAGRAM PLATE
2. NUT
3. WASHER
4. SCREW
5. RIVET
6. ID PLATE
7. HARNESS ASSY
8. CONTROL BOX
9. THERMOSTAT SWITCH
10. ELBOW
11. ELBOW
12. TEE
13. PLUG
14. NIPPLE
15. VALVE
16. SCREW
17. HOSE ASSY
18. CLAMP
19. HARNESS ASSY
20. RELIEF VALVE
21. BUSHING
22. CONNECTOR
23. TEE
24. NIPPLE
25. HOSE ASSY
26. CLAMP
27. VALVE
28. ELBOW
29. HOSE ASSY
30. CONNECTOR
31. ELBOW
32. DRAIN VALVE
33. PLUG
34. TEE
35. ADAPTER
36. ELBOW
37. HOSE ASSY
38. VALVE
39. RIVET
40. INSTRUCTION PLATE
41. U-CLAMP
42. EXHAUST HOSE
43. NUT
44. SCREW
45. HEATER ASSY
46. NUT
47. WASHER
48. SCREW
49. BRACKET
50. ELBOW
51. LOCKWASHER
52. NUT
53. SCREW
54. WASHER
55. EXHAUST PLATE
56. CONNECTOR
57. BUSHING
58. ELBOW
59. HEAT EXCHANGER

Figure 13-1. Fuel Burning Winterization Kit (Sheet 2 of 2)

connector (22), tee (23), and nipple (24).

(5) Disconnect hose assembly (37) from elbow (36), then remove elbow (36) and adapter (35).

(6) Disconnect exhaust hose (42) by removing U-bolt clamp (41).

(7) Remove heater assembly (45) from mounting bracket by undoing two adjustable straps.

(8) Secure heater assembly (45) to skid base and bracket using screws (44 and 48) and nuts (43).

NOTE

Apply thread sealing compound conforming to MIL-S-45180, Type III to all pipe threads prior to installation of elbows, bushings, and pipe connectors.

(9) Install elbow (10), then connect hose assembly (17).

(10) Install nipple (24), tee (23), and connector (22), then connect hose assembly (25).

(11) Install adapter (35) and elbow (36), then connect hose assembly (36).

(12) Reconnect plug P28 and negative battery cable.

b. Disassembly. To disassemble the heater assembly for repair or replacement of components, refer to figure 13-2 and disassemble the heater as necessary. Pay particular attention to the following:

(1) Remove cover (1). Tag and disconnect wires, as required, to affect repairs.

CAUTION

Use care when removing quartz rod (16) as it is easily broken if dropped.

(2) Remove receptacle assembly (3), terminal block (5), and flame switch assembly (8).

(3) Remove igniter (18), and gasket (19).

NOTE

Do not remove regulator valve assembly (36) until casing (42) has been removed.

(4) Remove burner assembly (49), and coolant pump and motor assembly (56) as a complete assembly.

NOTE

Coolant pump (57) cannot be removed as a complete assembly. The unit must be disassembled during removal as the pump rotor (68) is secured to the motor shaft by a setscrew (67).

(5) Before disassembly of the coolant pump, make an alignment mark across adapter (69), cam ring (64), and plate (59) for correct alignment during reassembly.

c. Cleaning.

WARNING

Cleaning solvent trichloroethane (Tri-ethane) 1.1.1 (MIL-T-81533A) is flammable and toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

see 05-1 (1) Clean electrical components with a cloth moistened with an cleaning solvent, tri-ethane 1.1.1, (MIL-T-81533), and dry thoroughly.

(2) Remove carbon deposits from burner assembly using a suitable wire brush.

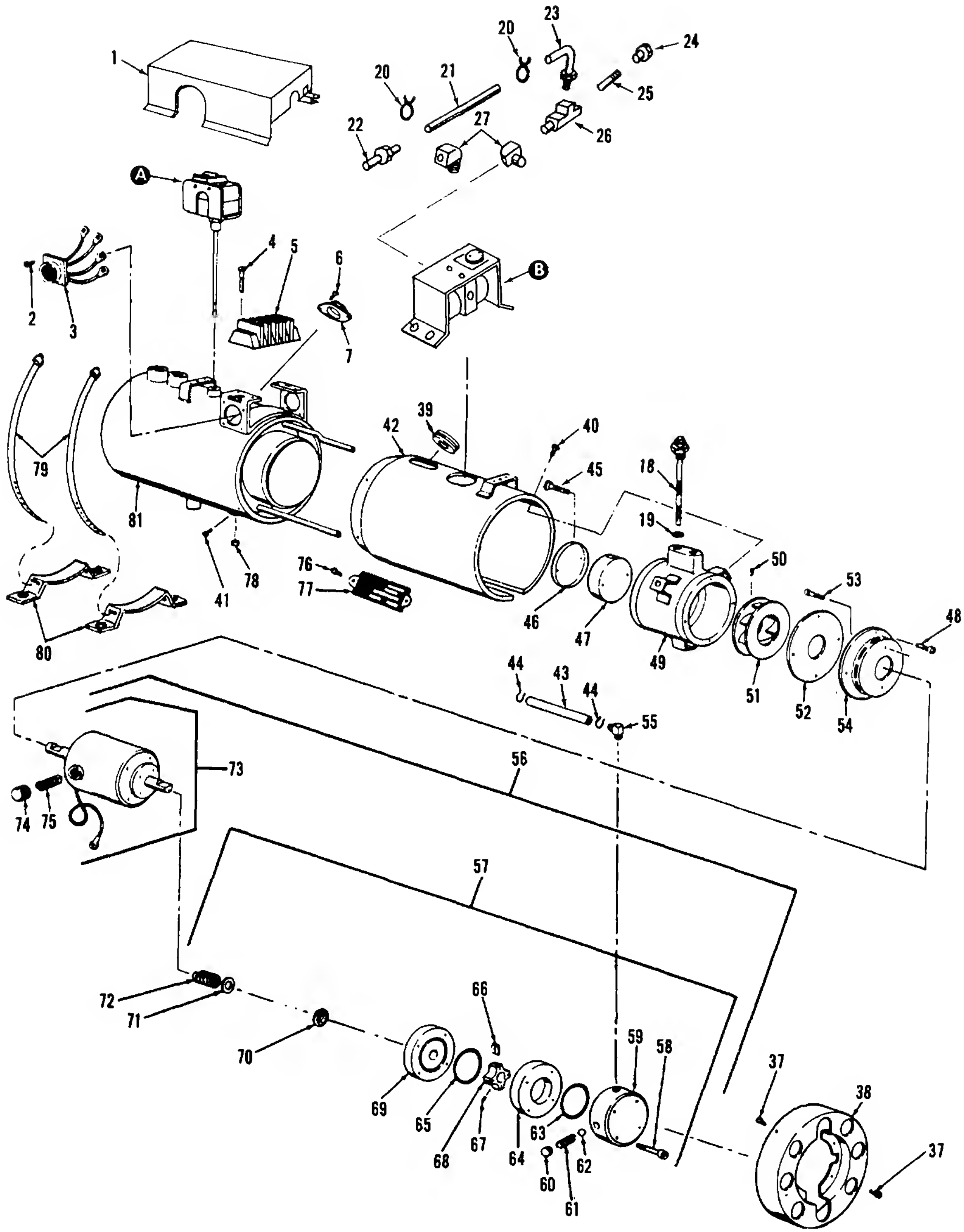
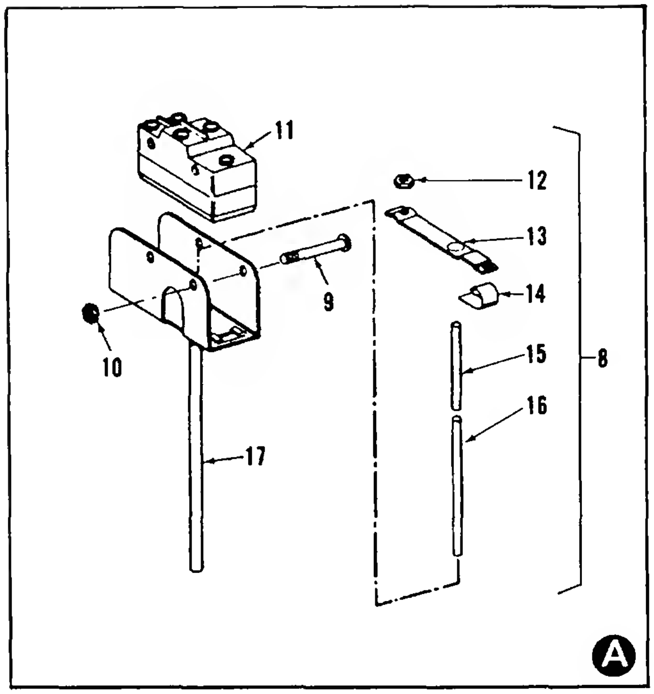


Figure 13-2. Fuel Burning Winterization Kit Heater, Exploded View (Sheet 1 of 3)



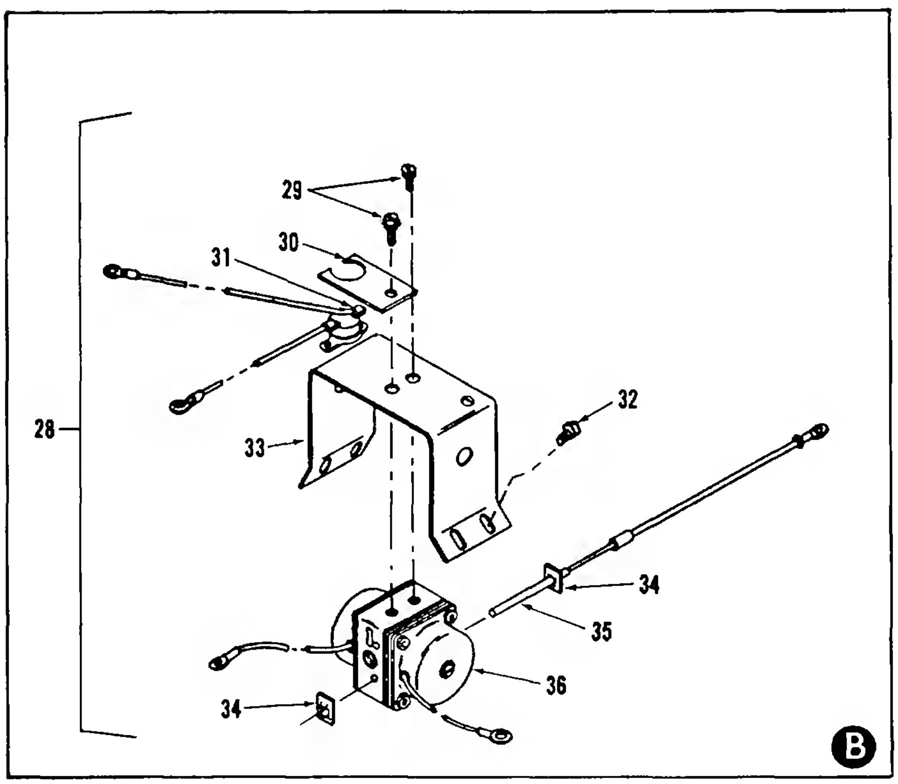


Figure 13-2. Fuel Burning Winterization Kit Heater, Exploded View (Sheet 2 of 3)

1. COVER
2. SCREW
3. RECEPTACLE ASSY
4. SCREW
5. TERMINAL BLOCK
6. SCREW
7. LIMIT SWITCH
8. FLAME SWITCH ASSY
9. SCREW
10. NUT
11. MICROSWITCH
12. LOCKNUT
13. LEVER
14. SPRING
15. ROD
16. QUARTZ ROD
17. FRAME ASSY
18. IGNITER
19. GASKET
20. HOSE CLAMP
21. FUEL HOSE
22. CONNECTOR
23. TUBE ASSY
24. PLUG
25. ORIFICE ASSY
26. TEE ADAPTER
27. ELBOW
28. BRACKET AND RELAY ASSY
29. SCREW
30. BRACKET
31. THERMOSTAT ASSY
32. SCREW
33. BRACKET
34. NUT
35. ELEMENT ASSY
36. REGULATOR VALVE ASSY
37. SCREW
38. COVER
39. GROMMET
40. SCREW
41. SCREW
42. CASING
43. HOSE
44. CLAMP
45. SCREW
46. RETAINER
47. VAPORIZER
48. SCREW
49. BURNER ASSY
50. SETSCREW
51. FAN
52. PLATE
53. SCREW
54. INLET
55. ELBOW
56. COOLANT PUMP AND MOTOR ASSY
57. COOLANT PUMP ASSY
58. SCREW
59. PLATE
60. PLUG
61. SPRING
62. BALL
63. PACKING
64. CAM RING
65. PACKING
66. BLADE
67. SETSCREW
68. ROTOR
69. ADAPTER
70. CAGE AND SEAL ASSY
71. SEAL WASHER
72. SEAL SPRING
73. BLOWER MOTOR ASSY
74. BRUSH CAP
75. BRUSH AND SPRING
76. SCREW
77. NAMEPLATE
78. DRAIN PLATE
79. CLAMP
80. BRACKET
81. HEAT EXCHANGER

Figure 13-2. Fuel Burning Winterization Kit Heater, Exploded View (Sheet 3 of 3)

(3) Clean orifice assembly by forcing filtered compressed air through orifice in the reverse flow direction.

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

(4) Clean parts using cleaning solvent, P-D-680, Type II, and dry thoroughly.

d. Inspection.

(1) Inspect components for cracks, dents, distortion, burrs, nicks, and damaged threads.

(2) Inspect insulation for damage.

(3) Inspect springs for condition. Inspect spring (61, figure 13-2). Using a spring compressor, apply a load of approximately 1 pound (0.45 kg) and compress spring to a working length of 0.750 inch (19.05 mm). Spring should measure 1.164 inches (29.56 mm) after test.

(4) Inspect receptacle assembly (3) for loose connections and bent or broken terminal pins. Check for short to case and surrounding pins. Check for continuity between wires and terminal pins.

(5) Inspect orifice assembly (25) for proper orifice opening. Opening should be 0.012 inch (0.305 mm) diameter.

(6) Inspect regulator valve assembly (36) for damaged leads and other obvious signs of damage.

(7) Inspect flame switch assembly (8) for loose pivot points.

(8) Inspect igniter (19) for broken coil.

(9) Inspect fan (51) for loose or damaged blades.

(10) Using a dial indicator, check end play on shaft of blower motor assembly (73). Grasp short shaft end and rotate in either direction, at the same time moving in and out. The end play should not exceed 0.010 to 0.025 inch (0.254 to 0.635 mm).

(11) Inspect adapter (69) for damaged or scored face, warped condition, and damaged seal face. Inspect for motor shaft bore wear. Refer to figure 13-3 for limits.

(12) Inspect cage and seal assembly (70) for scored or damaged seal face.

(13) Inspect rotor (68) and blades for damage and wear. Refer to figure 13-3 for limits.

(14) Inspect cam ring (64) for damaged or scored bore. Inspect for warped condition. Both faces must be parallel within 0.001 inch (0.254 mm) T.I.R.

(15) Inspect plate (59) for damaged or scored face.

e. Test of Regulator Valve Assembly.

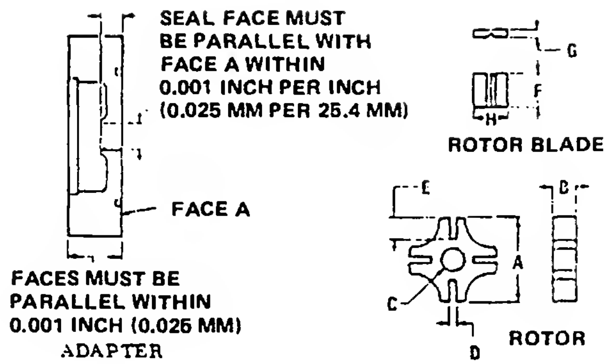
(1) Check resistance of regulator valve assembly (36, figure 13-2) solenoid coil. Resistance should be 150 ohms.

(2) Test fuel flow. Connect filtered 7 psi (48 kPa) fuel supply to regulator valve, and apply 24 V dc to valve solenoid.

(3) Using a stopwatch, time the fuel flow into a graduated container. Flow should measure 21 to 23 cubic centimeters per minute (approximately 1/4 pint in 5 minutes).

(4) If fuel flow rate is not within these tolerances adjust valve. Turn adjusting screw clockwise to increase flow rate or counterclockwise to decrease flow rate.

(5) Remove 24 V dc from valve solenoid, and check for leakage through valve.



ITEM	DIMENSION	DIMENSIONAL LIMITS INCHES (MM)
ROTOR HEAD DIAMETER	A	0.904 TO 0.906 (22.962 TO 23.013)
ROTOR HEAD LENGTH	B	0.243 TO 0.248 (6.248 TO 6.299)
ROTOR BORE DIAMETER	C	0.03033 TO 0.3038 (7.7038 TO 7.7165)
ROTOR BLADE SLOT WIDTH	D	0.935 TO 0.945 (33.749 TO 24.003)
ROTOR BLADE SLOT DEPTH	E	0.263 TO 0.268 (6.680 TO 6.807)
BLADE HEIGHT	F	0.247 TO 0.249 (6.274 TO 6.325)
BLADE THICKNESS	G	0.091 TO 0.093 (2.286 TO 2.362)
BLADE WIDTH	H	0.247 TO 0.249 (6.274 TO 6.325)
ADAPTER BORE DIAMETER	I	0.315 TO 0.318 (8.001 TO 8.007)

Figure 13-3. Coolant Pump Wear Limits

(6) Remove test equipment from valve. Replace valve that will not provide proper fuel flow, or one that leaks when voltage is removed.

f. Test of Igniter. Test igniter (18, figure 13-2) for proper resistance. Resistance should be 1 ohm.

g. Test of Coolant Pump and Motor Assembly. Coolant pump and motor assembly (56, figure 13-2) should be tested prior to reinstallation in the heater. Proceed as follows:

(1) Connect pump and motor assembly to equipment as shown in figure 13-4.

(2) Turn power switch to ON and run-in unit for approximately 15 minutes.

(3) Test relief valve by closing manual shutoff valve. Discharge pressure should not exceed 30 to 35 psi (207 to 241 kPa) when valve is closed. Open and close valve a few times to check consistency of valve performance. Replace relief valve spring if pressure exceeds 30 to 35 psi (207 to 241 kPa).

(4) To check pump for rated flow and pressure, adjust valve in discharge line until a reading of 2 psi (13.8 kPa) is obtained on pressure gage.

(5) Using a timer check for rated flow of 80 gph (303 liters per hour) at 2 psi (13.8 kPa) discharge pressure. Amperage draw should not exceed 6 amperes during this test.

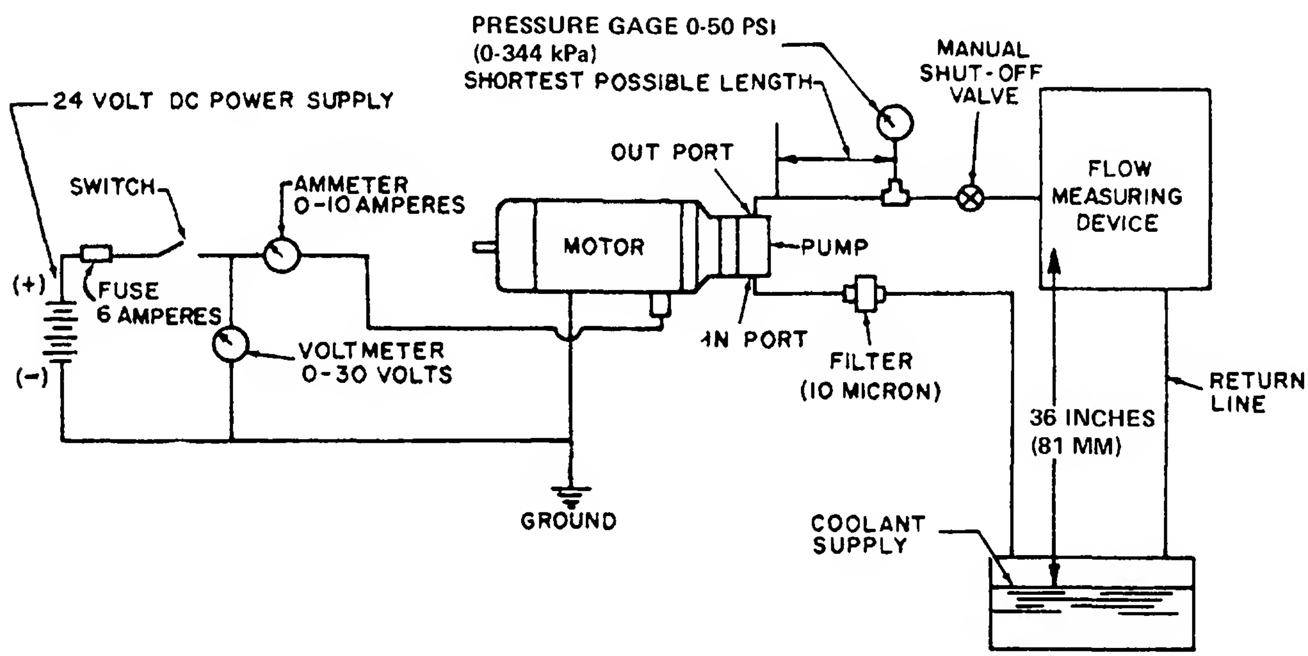


Figure 13-4. Coolant Pump, Test Setup

(6) Check motor rpm using a strobe light. Motor shaft speed should be 8500 rpm.

(7) Observe smoothness of opration of both pump and motor. Seal leakage of 1 cubic centimeter per hour (seal may show signs of dampness) is maximum when pump is operating at 3 psi (20.7 kPa) discharge pressure.

(8) Turn power supply to OFF; then remove discharge line and fitting from OUT ports. Plug this port and apply 40 psi (275.6 kPa) hydrostatic pressure for 20 minutes. No leakage shall be evident during this test.

(9) Remove test equipment.

h. Repair.

(1) The seal face of adapter (69, figure 13-2) and seal face of cage and seal assembly (70) can be dressed to remove minor nicks, scratches, or scoring. Remove only material necessary for clean up seal face. Seal face must be parallel with rotor side of adapter within 0.001 inch (0.025 min) per inch. Replace either part if imperfections cannot be dressed out.

(2) Straighten distorted parts.

(3) Remove burrs or nicks using a stone or file.

i. Reassembly. Refer to figure 13-2 to reassemble the heater assembly. Pay particular attention to the following:

NOTE

The coolant pump assembly (57) cannot be assembled completely and installed as a separate unit. It is assembled as it is installed on the short shaft end of the motor.

(1) Apply a thin film of grease to packings (63 and 65) and cage and seal assembly (70).

(2) Install seal spring (72) and seal washer (71) over end of motor shaft. Install cage and seal assembly (70) over end of motor shaft with seal face facing outward.

(3) Install pump adapter (69) over motor shaft and align holes with tapped holes in motor.

NOTE

Make certain that adapter (69) and cam ring (64) are tightly compressed together when determining the 0.002 inch (0.051 mm) clearance, otherwise a false reading will be obtained.

(4) Install pump rotor (68) on motor shaft and temporarily tighten rotor setscrew (67). Place packing (65) in groove of pump adapter (69). Place cam ring (64) in position aligning scribe mark. With motor shaft end play taken up in direction of pump, make certain there is at least 0.002 inch (0.501 mm) clearance between outer face of cam ring (64) and outer face of rotor (68). Move rotor back or forth as necessary to produce this clearance; then tighten setscrew (67).

(5) Install rotor blades (66) in rotor slots, making sure that grooves in blades face away from direction of rotation. Pump rotates counterclockwise when viewing end of port plate (59).

(6) Place packing (63) in groove of port plate (59); then position plate against cam ring (64). Align scribe marks, and tighten screws (58) evenly.

(7) Test coolant pump assembly (57). Refer to step g, above.

WARNING

Corrosion preventive compound, MIL-C-6529 is flammable. Take suitable precautions. Do not smoke.

(8) After coolant pump has been reassembled and tested, flush with corrosion preventive compound, Military Specification MIL-C-6529, and drain.

NOTE

Make certain that the lead wire from blower motor assembly (73) is on the side of the blower opposite the nameplate.

(9) Assemble motor and pump assembly (56), inlet (54), plate (52), and fan (51) before installing into burner assembly (49).

(10) Install burner assembly (49) and casing (42).

(11) Install cover (38).

(12) Install regulator valve assembly (36), gasket (19), and igniter (18).

CAUTION

Use care when installing quartz rod (16) as it is easily broken if dropped.

(13) After installing quartz rod (16), gently raise the rod up and down to see if it moves freely in the stainless tube. Also make sure at least 1/32 inch (0.79 mm) extends out of tube when rod is resting on bottom.

(14) Install flame switch assembly (8) and terminal block (5).

(15) Install receptacle assembly (3) with key located on the top.

(16) Adjust flame switch (8), refer to the Operator and Organizational Maintenance Manual.

(17) Install cover (1).

13-4. WIRING HARNESSES. If a wiring harness has sustained damage to 30 percent or more of the wires in the harness, the wiring harness must be completely rebuilt. Refer to the Operator and Organizational Maintenance Manual for illustrations of the wiring harnesses which interconnect the various components of the fuel burning winterization kit.

a. Each illustration includes a wire run list which provides wire origination, destination, identification number wire length, preparation requirements, and end preparation.

b. Refabricate a new wiring harness using the appropriate illustration, and the wire run list for proper wire connection.

c. If a wiring harness cannot be identified, compare it with the illustrations until proper identification is made. Check numbers stamped on wires against those in the wire run list to ensure proper identification before proceeding with refabrication.

d. Wiring shall be neatly laced through the use of self-locking nylon straps, located at intervals not to exceed 3 inches (76.2 mm), and also at each wire break out.

e. Soldering shall be in accordance with requirement 5 of MIL-STD-454 using Sn60 solder.

f. Wire numbering shall be in accordance with MIL-W-5088, except that length between adjacent groups of numbers shall not exceed 6 inches (152.4 mm).

g. Cut insulation tubing in 1/2-inch pieces (12.7 mm) and install around wires at pins of connectors and receptacles.

h. Install nylon filler plugs MS25251-16 in unused openings of connectors.

13-5. CONTROL BOX ASSEMBLY. The fuel burning winterization kit control box assembly is located to the right of the control cubicle and consists of an ON-OFF switch, a circuit breaker, press-to-test indicator light, and two

receptacles for interconnection. The ON-OFF switch permits starting of the heater assembly and provides a means for stopping the heater. When the switch is positioned to OFF, the heater motor will continue to operate for a period of approximatly 4-1/2 minutes to purge heated air and fuel from the heater. The circuit breaker is a manual reset type; it protects the heater circuitry in the event of an overload. The press-to-test indicator light illuminates to show that the heater is operating. It is also a means of checking system electrical power.

a. Removal. Refer to the Operator and Organizational Maintenance Manual to remove and replace the control box assemby.

b . Disassembly. Refer to figure 13-5 and disassemble the control box assembly as follows:

CAUTION

Prolonged use of soldering equipment can cause damage to components due to excessive heat.

NOTE

Disassemble the control box only to the extent necessary to effect repair or replacement of components.

(1) Remove screws (1) and pull plate (2) aside. Tag and disconnect wiring from plate components.

(2) Remove four nuts (3) and four screws (4) to remove connector (5).

(3) Remove four nuts (6) and four screws (7) to remove connector (8).

(4) Remove two screws (9) to remove cover (10).

(5) Remove lens (11), nut (12), washer (13), lamp (14), and indicator light (15).

(6) Remove terminal lugs (16, 17, 18, and 19) only if damaged.

(7) Remove nut (20) to remove circuit breaker (21).

(8) Remove nut (22), washer (23), and tab washer (24) to remove switch (25).

(9) Remove two screws (26) to remove component board assembly (27).

(10) Remove two screws (28) and two spacers (29).

(11) Unsolder diode (30) from terminals (31).

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

c. Cleaning. Clean components with a cloth moistened with cleaning solvent, P-D-680, Type II, and dry thoroughly.

d. Repair.

(1) Repair or replace defective control box wiring components in accordance with table 13-2.

(2) Repair dents and distortion in frame or covers.

e. Test of Circuit Breaker. Test the circuit breaker (21, figure 13-5) as follows:

(1) Using an ohmmeter set on the RX1 scale, read across the circuit breaker. With the circuit breaker in the closed position (ON), the reading should be zero ohm.

(2) Open the circuit breaker (OFF), select the RX100 scale, the meter should indicate infinity ohms.

(3) Connect the circuit breaker between a 28 V dc source and a resistive load, such that the current draw from the source is 16.73 amperes. The circuit breaker should not trip. If the circuit breaker trips, replace it.

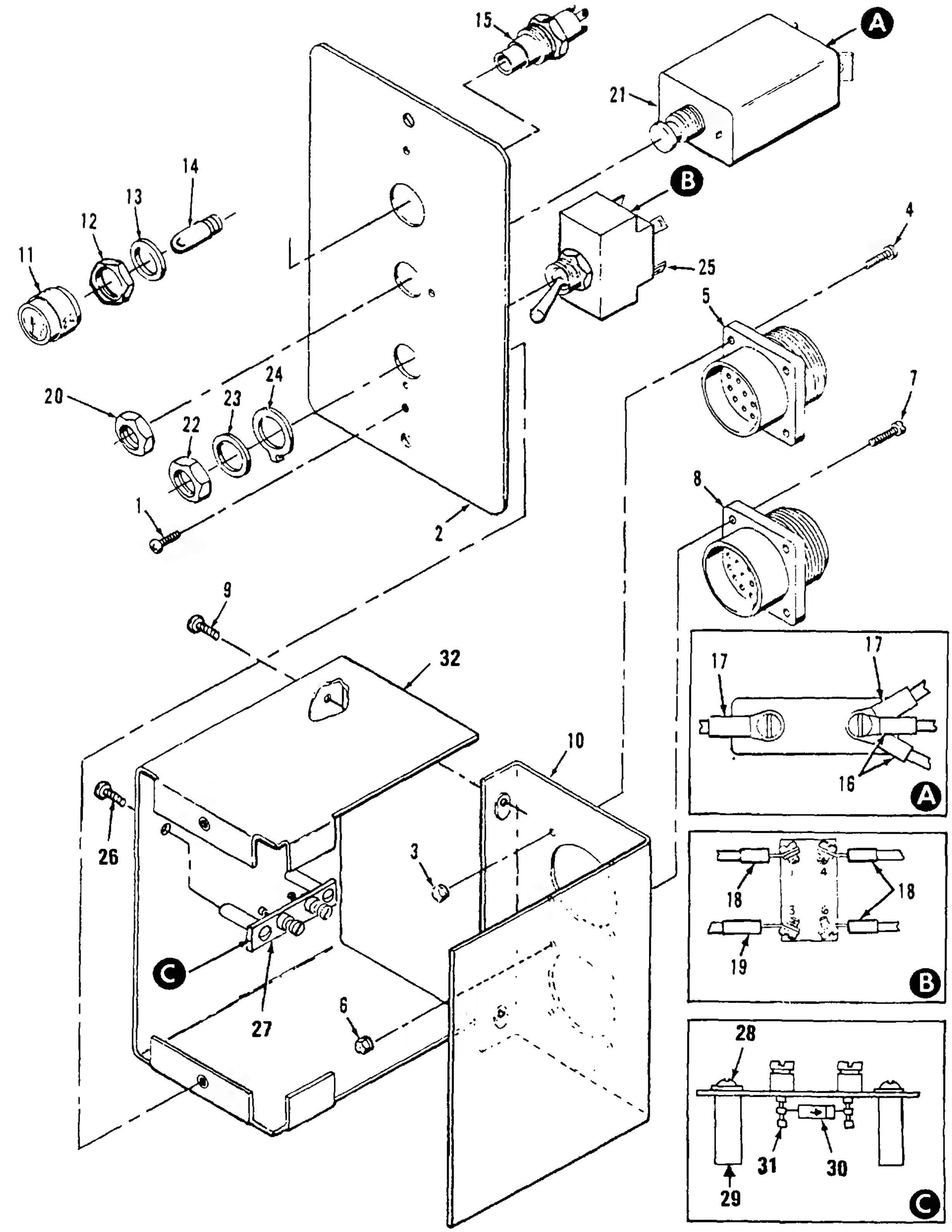


Figure 13-5. Fuel Burning Winterization Kit Control Box, Exploded View (Sheet 1 of 2)

1. SCREW	12. NUT	23. WASHER
2. PLATE	13. WASHER	24. TAB WASHER
3. NUT	14. LAMP	25. SWITCH
4. SCREW	15. INDICATOR LIGHT	26. SCREW
5. CONNECTOR	16. TERMINAL LUG	27. COMPONENT BOARD ASSY
6. NUT	17. TERMINAL LUG	28. SCREW
7. SCREW	18. TERMINAL LUG	29. SPACER
8. CONNECTOR	19. TERMINAL LUG	30. DIODE
9. SCREW	20. NUT	31. TERMINAL
10. COVER	21. CIRCUIT BREAKER	32. FRAME
11. LENS	22. NUT	

Figure 13-5. Fuel Burning Winterization Kit Control Box, Exploded View (Sheet 2 of 2)

f. Test of Power Switch. Test the power switch (25, figure 13-5) using an ohmmeter set on the RX1 scale. Check for continuity between terminals 4 and 6, and 1 and 3 with the switch in the ON position. If defective, replace.

g. Reassembly. Refer to figure 13-5 and reassemble the control box as follows:

(1) Install diode (30) across terminals (31).

(2) Replace two screws (28) and two spacers (29).

(3) Secure component board assembly (27) to frame (32) using two screws (26).

(4) Install switch (25) using tab washer (24), washer (23), and nut (22). Ensure that tab on tab washer (24) engages in hole on cover (2).

(5) Install circuit breaker (21) using nut (20).

(6) Install light assembly (15), lamp (14), washer (13), nut (12), and lens (11).

(7) Replace terminal lugs (16, 17, 18, and 19) if required. Remove tags and reconnect wires.

Table 13-2. Fuel Burning Winterization Kit Control Box Wire Termination Data

FROM	TERMINATION NOTE	TO	TERMINATION NOTE	WIRE TYPE	WIRE LENGTH INCHES (mm)
J26A	3	J27A	3	1	3 (76.2)
J26A	3	DS1-1	3, 4	2	4 (101.6)
J26B	3	CR1-2	5	2	5 (127)
J26C	3	J27C	3	1	3-1/2 (88.9)
J26D	3	S1-6	6	1	6 (152.4)
J26E	3	CB-1	7	1	3-1/2 (88.9)
J26B	3	S1-3	5	2	6 (152.4)
J27D	3	DS1-2	3, 4	2	5 (127)
J27E	3	CB-2	7	1	6 (152.4)
CB-2	8	DS1-3	3, 4	2	3 (76.2)
CB-2	8	S1-4	5	2	3 (76.2)
CR1-1	3	S1-1	5, 6	2	6 (152.4)

NOTES:
1. Wire is M5086/2-12-9 per MIL-W-5086/2.
2. Wire is M5086/2-16-9 per MIL-W-5086/2.
3. Solder.
4. Make good mechanical connection before soldering.
5. Secure end with terminal lug, MS25036-106.
6. Secure end with terminal lug, MS25036-111.
7. Secure end with terminal lug, MS25036-156.
8. Secure end with terminal lug, MS25036-153.
9. Refer to Operator and Organizational Maintenance for wiring diagram.

Section II. ELECTRIC WINTERIZATION KIT

13-6. GENERAL. The electric winterization kit preheats engine coolant and lubricating oil for ease of generator set starting in ambient temperatures down to -65°F (-53.9°C). The kit is integrally mounted in the generator set and consists of an electric coolant heater, control box, coolant pump, thermostat, coolant and drain valves, wiring, lines, and fittings. Heated coolant is circulated through the engine cooling system and oil pan heat exchanger by the coolant pump. Automatic heater cycling is controlled by the thermostat to prevent excessive coolant temperature. The heater, coolant pump, and thermostat are located in the left engine compartment. Power for kit operation may be obtained from any power source that supplies 205 to 240 volts, 50 or 60 Hertz, single-phase power.

13-7. TROUBLESHOOTING. This section contains troubleshooting information (refer to table 13-3) for locating and correcting the operating troubles which may develop in the electric winterization kit. Each malfunction for an individual component, unit, or system is followed by a list of tests or inspections which will help you to determine the probable cause and corrective actions in the order listed.

13-8. REPAIR. Repair the electric winterization kit by replacing defective components, and in accordance with the following:

a. Rebuild wiring harnesses in accordance with paragraph 13-10.

b. Replace defective control box components in accordance with paragraph 13-11.

13-9. COOLANT PUMP AND MOTOR. The following paragraphs provide replacement and test procedures for the coolant pump and motor (19, figure 13-6).

a. Removal.

WARNING

Make sure kit power cable is removed from power supply.

(1) Place a container under COOLANT DRAIN at side of skid base. Close valves (10 and 50). Open drain valve (47).

(2) Disconnect hose assembly (12) from elbow (13), then remove elbow (13).

(3) Disconnect hose assembly (5) from elbow (11), then remove elbow (11).

(4) Unplug connector from coolant pump and motor assembly (19), then remove coolant pump and motor by removing two screws (14), two lockwashers (15), two washers (16), clamp (17), and bracket (18).

b. Test.

(1) Install motor and pump assembly in a test setup (see figure 13-4) and install proper fittings in inlet and outlet ports. Attach hose line from supply tank to port marked IN.

(2) Attach discharge line with pressure gage and manual shutoff valve to port marked OUT. Connect a flow measuring device and return line.

(3) Attach electrical plug to motor receptacle and plug into dc power supply.

(4) Turn power switch on and run unit for approximately 15 minutes on 24 V dc.

Table 13-3. Electric Winterization Kit, Troubleshooting

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

1. ELECTRIC HEATER ON-OFF SWITCH POSITIONED TO ON AND HEATER ON INDICATOR ENERGIZED, BUT COOLANT IS NOT CIRCULATING AND COOLANT TEMPERATURE NOT RISING.

Test control box (refer to paragraph 13-11).

Replace defective control box components (refer to paragraph 13-11).

Test coolant pump and motor assembly (refer to paragraph 13-9).

Replace defective coolant pump and motor assembly (refer to paragraph 13-9).

2. ELECTRIC HEATER ON-OFF SWITCH POSITIONED TO ON AND INDICATOR DOES NOT ENERGIZE.

Step 1. Test for power to input receptacle J49, terminals A and B.

Remove cable and measure voltage to these two terminals. It should be between 205 to 240 V ac, 50/60 Hertz.

Step 2. Test control box (refer to paragraph 13-11).

Replace defective control box components (refer to paragraph 13-11).

(5) Close valve in outlet line. (Make sure discharge pressure does not exceed a maximum of 30 to 40 psi (207 to 276 kPa) when closing this valve). Open and close valve a few times to check consistency of relief valve performance.

(6) To check pump for rated flow and pressure, adjust valve in discharge line until a reading of 2 psi (13.8 kPa) is obtained on pressure gage. Using a timer, check for rated coolant flow of 80 gph (303 liters per hour) minimum at 2 psi (13.8 kPa) discharge

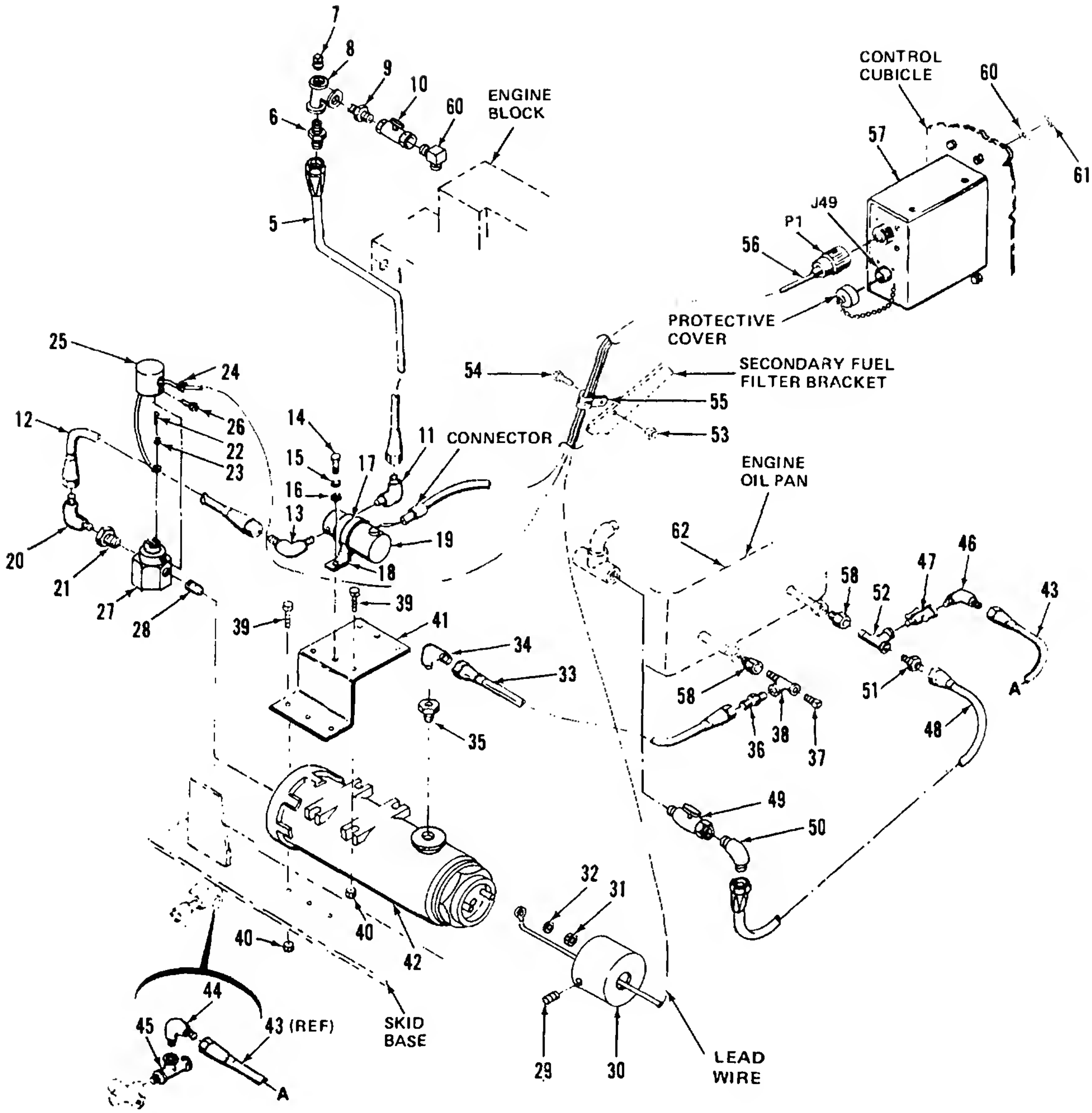
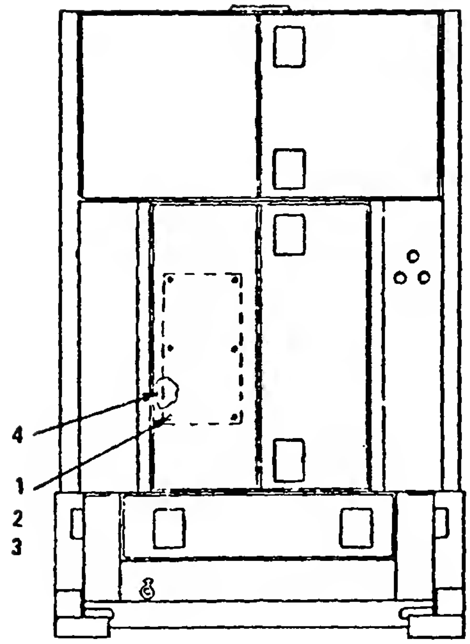


Figure 13-6. Electric Winterization Kit (Sheet 1 of 2)



REAR VIEW OF GENERATOR SET

1. NUT
2. WASHER
3. SCREW
4. INSTRUCTION PLATE
5. HOSE ASSY
6. CONNECTOR
7. PLUG
8. TEE
9. NIPPLE
10. COOLANT VALVE
11. ELBOW
12. HOSE ASSY
13. ELBOW
14. BOLT
15. LOCKWASHER
16. WASHER
17. CLAMP
18. BRACKET
19. COOLANT PUMP AND MOTOR ASSY
20. ELBOW
21. REDUCER
22. SCREW
23. WASHER
24. GROMMET
25. COVER
26. SCREW
27. THERMOSTAT
28. NIPPLE
29. SCREW
30. COVER
31. NUT
32. WASHER
33. HOSE ASSY
34. ELBOW
35. REDUCER
36. CONNECTOR
37. PLUG
38. TEE
39. SCREW
40. WASHER
41. BRACKET
42. HEATER
43. HOSE ASSY
44. ELBOW
45. TEE
46. ELBOW
47. DRAIN VALVE
48. HOSE ASSY
49. CONNECTOR
50. COOLANT VALVE
51. CONNECTOR
52. TEE
53. NUT
54. SCREW
55. CLAMP
56. HARNESS ASSY
57. CONTROL BOX
58. CONNECTOR
59. ELBOW
60. WASHER
61. SCREW
62. HEAT EXCHANGER

Figure 13-6. Electric Winterization Kit (Sheet 2 of 2)

pressure (at 68°F (20°C)). Amperage draw must not exceed 3.3 amperes during this test. The drive motor speed should be approximately 7500 rpm. Observe smoothness of operation of both pump and motor. Seal leakage of 1 cc (1/3 ounce) per hour is maximum when pump is operating at 2 psi (13.8 kPa) discharge.

(7) Turn power supply off, then remove discharge line and fitting from OUT port and apply 40 psi (276 kPa) hydrostatic pressure for 20 minutes to inlet port. No leakage shall be evident during this test.

c. Replacement.

(1) Install clamp (17, figure 13-6) and bracket (18) on coolant pump and motor assembly (19), then install coolant pump and motor assembly to skid base using two washers (16), two lockwashers (15), and two bolts (14).

NOTE

Apply thread sealing compound conforming to MIL-S-45180, Type III to all pipe threads prior to installation.

(2) Install elbows (11 and 13), then connect hose assemblies (12 and 5).

(3) Attach connector to coolant pump and motor assembly (19).

(4) Open valves (10 and 50), then close valve (47).

(5) Connect kit power cable.

(6) Service radiator in accordance with the Operator and Organizational Maintenance Manual.

13-10. WIRING HARNESSES. If a wiring harness has sustained damage to 30 percent or more of the wires in the harness, the wiring harness must be completely rebuilt. Refer to the Operator and Organizational Maintenance Manual for illustrations of the wiring harnesses which interconnect the various components of the electric winterization kit.

a. Each illustration includes a wire run list which provides wire origination, destination, identification number, wire length, preparation requirements, and end preparation.

b. Refabricate a new wiring harness using the appropriate illustration, and the wire run list for proper wire connection.

c. If a wiring harness cannot be identified, compare it with the illustrations until proper identification is made. Check numbers stamped on wires against those in the wire run list to ensure proper identification before proceeding with refabrication.

d. Wiring shall be neatly laced through the use of self-locking nylon straps, located at intervals not to exceed 3 inches (76.2 mm), and also at each wire break out.

e. Soldering shall be in accordance with requirement 5 of MIL-STD-454 using Sn60 solder.

f. Wire numbering shall be in accordance with MIL-W-5088, except that length between adjacent groups of numbers shall not exceed 6 inches (152.4 mm).

g. Cut insulation tubing in 1/2-inch pieces (12.7 mm) and install around wires at pins of connectors and receptacles.

h. Install nylon filler plugs MS25251-16 in unused openings of connectors.

13-11. ELECTRIC WINTERIZATION CONTROL BOX. The control box contains the operating controls for the electric winterization kit. Incorporated in the control box are the power (on-off) switch, fuse, step-down transformer, full-wave diode rectifier, and heater indicator. The switch turns the kit components on or off, and the fuse protects the kit components from excessive current. The step-down transformer converts input voltage from

an external power supply to 33 V ac which in turn is converted to approximately 24 V dc by the full-wave diode rectifier to power the coolant pump. The indicator lights whenever the kit is operating.

a. Removal. Remove the control box in accordance with the Operator and Organizational Maintenance Manual.

b. Test.

NOTE

Refer to the Operator and Organizational Maintenance Manual for the electric winterization kit schematic diagram.

(1) Connect control box to test equipment as illustrated in figure 13-7.

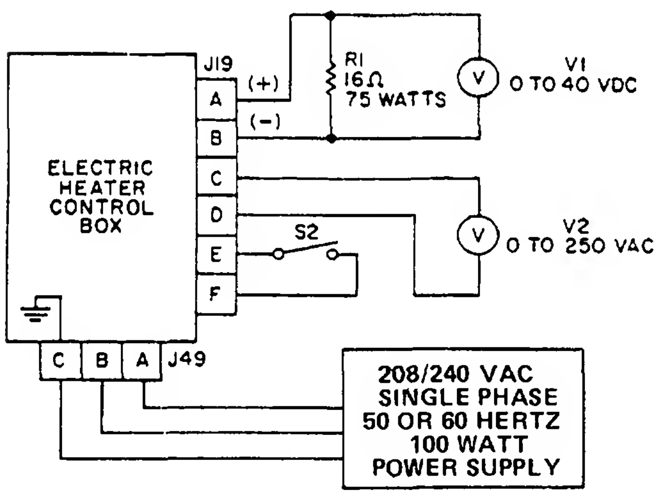


Figure 13-7. Electric Winterization Kit Control Box, Test Setup

(2) Perform test procedures specified in table 13-4.

c. Disassembly. Refer to figure 13-8 and disassemble the control box as follows:

NOTE

Disassemble the control box only to the extent necessary to effect repair.

(1) Remove six screws (1) and cover (2).

(2) Tag and disconnect harness wires from components and terminal board, then remove harness (3), four nuts (4), four screws (5), four nuts (6), four screws (7) and wiring harness (9).

(3) Remove cover (8) only if damaged.

(4) Remove four diodes (11), by removing terminal lugs (10) from terminal board.

(5) Remove terminal board (14) by removing two nuts (12) and two screws (13).

(6) Remove transformer (17) by removing four nuts (15) and four screws (16).

(7) Remove resistor (21) by removing two screws (20), two nuts (18), and two lockwashers (19).

(8) Remove knob (23) by removing screw (22).

(9) Remove switch (25) by removing three screws (24).

(10) Remove cap (26), fuse (27), two screws (29), nuts (28), plate (30), and fuseholder (31).

(11) Remove lens (32), lamp (33), nut (34), washer (35), and light housing (36).

WARNING

Dry cleaning solvent, P-D-680, Type II, is flammable and moderately toxic to the skin, eyes, and respiratory tract. Skin, eye, and respiratory protection is required.

d. Cleaning. Clean components with a clean lint-free cloth moistened with cleaning solvent, P-D-680, Type II

e. Inspection.

(1) Inspect sheet metal parts for cracks, distortion, dents, and bent corners.

(2) Inspect transformer for burrs and defective insulation.

(3) Check switch, lamp, light, fuse, and fuseholder for continuity.

(4) Inspect terminal board for damaged or cracked insulation.

(5) Check threads for damage.

f. Repair.

(1) Straighten dented or distorted sheet metal parts.

(2) Repair or rebuild defective wiring harness.

(3) Replace defective components during reassembly.

g. Reassembly.

(1) Install light housing (36) using washer (35), nut (34), bulb (33) and lens (32).

(2) Install fuseholder (31) and plate (30) using two screws (29) and two nuts (28).

(3) Install fuse (27) and cap (26).

(4) Install switch (25) using three screws (24) and knob (23) using screw (22).

(5) Install resistor (21) using two screws (20), two washers (19), and two nuts (18).

(6) Install transformer (17) using four screws (16) and four nuts (15).

(7) Install terminal board (14) using two screws (13) and two nuts (12).

(8) If removed, reconnect terminal lugs (10) of the four diodes (11), that secure diodes to terminal board (14).

(9) Install wiring harness (9) and cover (8) using four screws (7), four nuts (6), four screws (5), and four nuts (4).

(10) Remove tags and install wiring harness (3).

(11) Install cover (2) using six screws (1).

h. Replacement. Install control box in control panel in accordance with the Operator and Organizational Maintenance Manual.

Table 13-4. Electric Winterization Kit Control Box, Procedural Analysis

STEP	TEST CONDITION		REQUIRED RESULT	PROBABLE CAUSE FOR IMPROPER RESULT	CHECK OUT PROCEDURES
1.	Position heater control box switch to ON and apply 230 V ac. Close switch S2, refer to figure 13-7.	a.	Heater control box indicator DS1 should illuminate.	Defective resistor R20.	Check resistor value which should be 2.47K ohms.
				Defective indicator DS11.	Check indicator for continuity. There should be continuity.
		b.	Voltmeter V2 should indicate 230 V ac.	Defective transformer T1.	Measure voltage across secondary leads of T1 with a 0 to 50 V ac voltmeter. Voltage should be approximately 33 V ac.
		c.	Voltmeter V1 should indicate approximately 33 V ac.	Defective diodes CR23, CR24, CR25, or CR26.	Check forward and reverse resistance of diodes. Measure from anode (+) to cathode (-), value should be low. Reverse meter leads, value should be infinity.

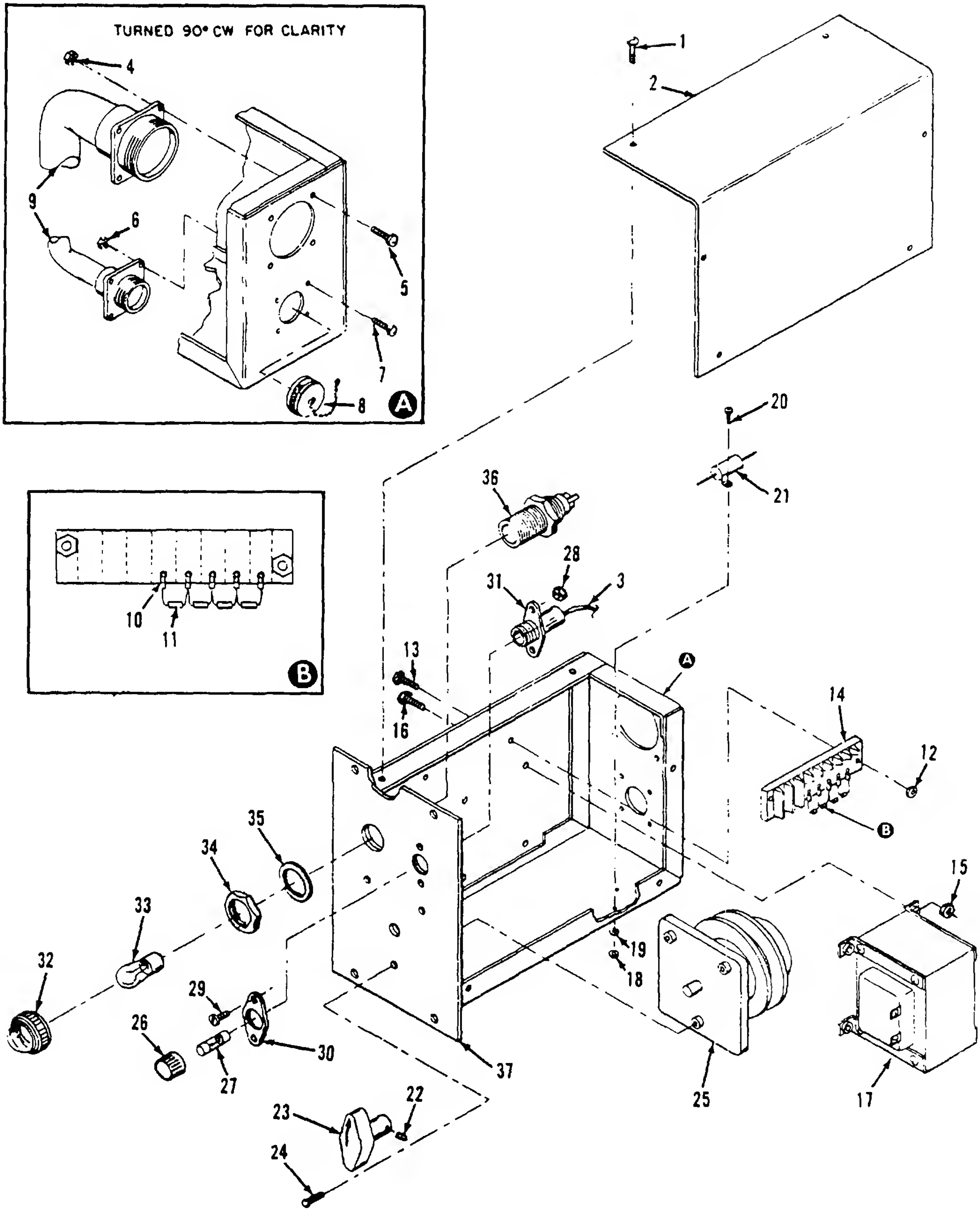


Figure 13-8. Electric Winterization Kit Control Box, Exploded View (Sheet 1 of 2)

1. SCREW
2. COVER
3. HARNESS
4. NUT
5. SCREW
6. NUT
7. SCREW
8. COVER
9. HARNESS
10. TERMINAL LUG
11. DIODE
12. NUT
13. SCREW
14. TERMINAL BOARD
15. NUT
16. SCREW
17. TRANSFORMER
18. NUT
19. LOCKWASHER
20. SCREW
21. RESISTOR
22. SCREW
23. KNOB
24. SCREW
25. SWITCH
26. CAP
27. FUSE
28. NUT
29. SCREW
30. PLATE
31. FUSEHOLDER
32. LENS
33. LAMP
34. NUT
35. WASHER
36. LIGHT HOUSING
37. CHASSIS

Figure 13-8. Electric Winterization Kit Control Box, Exploded View (Sheet 2 of 2)

CHAPTER 14

GENERATOR SET TEST AND INSPECTION AFTER REPAIR OR OVERHAUL

Section I. GENERAL REQUIREMENTS

14-1. The activity performing the repair or overhaul is responsible for the performance of all applicable tests and inspections specified herein. Activities performing maintenance on any portion of the generator set must perform those tests and inspections required by the applicable component or system repair instruction.

Section II. INSPECTION

14-2. GENERAL. A thorough inspection of the generator set shall be conducted to ensure that workmanship and materials are satisfactory. The inspection shall be conducted each time the generator set is overhauled or rebuilt.

14-3. HOUSING AND FRAME INSPECTION.

a. Check that lifting eyes are installed and firmly secured.
b. Check that drain holes are open to prevent moisture accumulation.
c. Ensure that exposed parts are properly treated to resist corrosion.
d. Open and close panel doors, engine area doors, and generator area doors to ensure proper installation and freedom of motion.
e. Inspect door gasketing to ensure that it is weatherproof.
f. Check that all caps and covers are equipped with ties or chains to prevent loss.

14-4. ENGINE INSPECTION.

a. Check mounting bolts of all components and accessories to ensure that they are firmly secured.
b. Check designation and data plates for legibility.
c. Ensure that fuel and lubricating oil lines are protected from damage due to vibration.

14-5. GENERATOR INSPECTION.

a. Ensure that generator leads are properly identified and protected from damage due to vibration.
b. Ensure that inspection openings are protected by screens or protective plates.
c. Check that the engine generator screws are firmly secured. See table 1-2 for proper torque values.

14-6. ELECTRICAL ACCESSORIES INSPECTION.

a. Check all cable and harness assemblies for secure fastenings and protection against chafing and vibration.
b. Ensure that all cable and harness connectors are firmly secured in their proper place.

Section III. OPERATIONAL TESTS

14-7. GENERAL. All tests should be performed under the following conditions:

a. All tests shall be made at ambient temperatures.

b. All tests instrumentation will be in accordance with Military Standardization Handbook MIL-HDBK-705 and Military Standard MIL-STD-705, as applicable.

c. Temperatures will be measured by means of appropriately located thermocouples and properly calibrated read-out devices. Thermocouples will be insulated from contact with other metals. Temperatures will be recorded in degrees Fahrenheit or Centigrade, depending on the instrument scale, but will be reduced in degrees Fahrenheit in all cases. Barometric pressure will be measured by a mercurial barometer, which will be corrected for the temperature of the scale, the mercury for vapor pressure and for the location of the barometer with regard to altitude and latitude. Aneroid barometers will not be used.

d. Perform engine assembly run-in and adjustments (paragraph 14-8).

e. Operational procedures required in support of the indvidual test specified herein shall be performed as outlined in the Operator and Organizational Maintenance Manual.

f. Record test results as required by local instructions.

14-8. ENGINE ASSEMBLY RUN-IN AND ADJUSTMENTS.

NOTE

Make sure all necessary adjustments have been performed and engine is fully serviced before starting test.

Connect engine assembly to a suitable engine dynamometer equipped with a cooling system and a means of monitoring engine oil pressure, coolant temperature, and engine rpm.

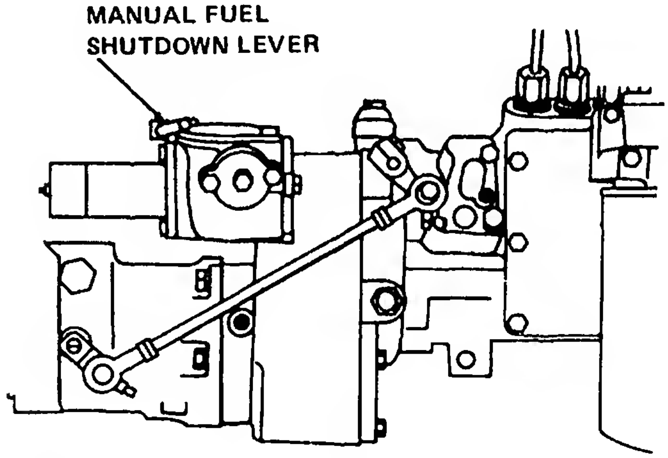
a. Pre-Run-In Checks.

NOTE

Rotate engine in a clockwise direction only, when viewing engine from front.

(1) Manually rotate engine by applying a 1-1/8 socket with extension handle to crankshaft nut inside of damper.

(2) Hold manual fuel shutdown lever in the closed (off) position (see figure 14-1).



NOTE
SHOWN IN ON (OPEN) POSITION.
PULL TOWARD OPERATOR FOR
OFF (CLOSED) POSITION.

Figure 14-1. Location of Manual Fuel Shutdown Lever

CAUTION

Do not crank starter motor more than 15 seconds at a time. Allow 3 minutes between crankings for starter motor to cool.

(3) Turn engine over using starter until oil pressure builds up to 50 +/-10 psig (345 +/-65 kPa). Oil pressure should build up within 15 seconds.

(4) Release manual fuel shutdown lever. Inspect all fluid systems for signs of leakage.

b. Governor Speed Setting Adjustment. Adjust governor low and high speed stops as follows:

(1) Loosen nut (5, figure 11-5) and screw (4) counterclockwise until the screw is free of speeder spring (55) pressure.

CAUTION

Do not crank engine for more than 15 seconds at a time. Permit starter to cool a minimum of 3 minutes between crankings.

(2) Crank engine over with starter and turn low speed stop screw (4) clockwise until governor output shaft (24) rotates. Continue turning low speed stop screw (4) until engine starts.

(3) Permit engine to run a minimum of 5 minutes for warmup and adjust low speed stop screw (4) to obtain 1200 rpm idle speed. Clockwise rotation will increase speed. Hold screw in position and tighten nut (5). Recheck rpm setting.

(4) Rotate speed adjusting shaft (37) to maximum speed position and monitor engine speed. Do not exceed 2300 rpm.

(5) Engine high speed stop setting should be 2250 rpm. To adjust high speed stop, loosen nut (94) and rotate high speed stop screw (93) to obtain 2250 rpm when speed adjusting shaft (37) is in maximum speed position. Clockwise rotation will increase engine rpm setting. Tighten locknut and recheck engine speed.

(6) If engine surges during warmup, loosen knurled thumbscrew (14) while engine is running and slide external droop bracket (17) towards maximum position (away from governor ball head assembly (63 through 70).

(7) When the engine is warmed up, adjust the external droop bracket (17) as much towards minimum (toward ball head assembly) as possible while maintaining steady speed. Manually remove the engine fuel linkage to cause a temporary engine speed increase. If the engine returns to the original steady speed, the adjustment is satisfactory. If the engine speed does not settle out, increase droop slightly (approximately 1/16 of an inch (1.6 mm) movement of bracket (17) and test again. Continue to increase the droop until the operation is satisfactory.

c. Run-In. During run-in, monitor oil pressure and coolant temperature and check for unusual noise and vibrations. Discontinue run-in if oil pressure drops below 20 psi (60 kPa), if coolant temperature exceeds 222°F (104.5°C), or if unusual noise and vibrations occur.

(1) Start engine and operate at low speed (approximately 800 rpm) and with no load.

NOTE

Three-quarter speeds are 1125 rpm for 50 hertz operation, and 1350 rpm for 60 hertz operation.

(2) Operate engine at 3/4 rated speed and at 50 KW for 15 minutes.

NOTE

Rated speeds are 1500 rpm for 50 hertz operation, and 1800 rpm for 60 hertz operation.

(3) Operate engine at rated speed and at 100 KW for 30 minutes.

NOTE

Required torque for cylinder head bolts after test to be 150 foot-pounds (203 Newton-meters) minimum.

(4) Shut down engine and tighten all bolts and nuts. Tighten cylinder head bolts, refer to figure 11-34.

(5) Inspect engine for leakage.

14-9. START AND STOP TEST. Test the generator set for evidence of abnormal start and stop conditions by performing the start and shutdown procedures as outlined in the Operator and Organizational Maintenance Manual. The generator set should be capable of starting promptly at any ambient temperature in the range of +125° to -25°F (51° to -31°C) without external heat.

a. Operate generator set at rated speed, voltage, and no-load for 15 minutes, then shutdown generator set.

b. Operate generator set at rated speed, voltage, and no-load for 15 minutes. Discontinue operation by de-energizing the dc circuit breaker.

c. Repeat start-stop procedures, as described above, two additional times. If any malfunction is noted, make necessary repairs before subjecting the generator set to the remaining tests.

14-10. INSTRUMENT CHECK. Test the generator set ammeter, voltmeter, and Hertz (frequency) meter for accuracy by comparing them with master instruments.

NOTE

This test shall be done in conjunction with other tests.

a. Adjust the meters to zero as outlined in the Operator and Organizational Maintenance Manual.

NOTE

The following test shall be repeated at all rated frequencies and at voltages of 120/208 and 240/416.

b. Connect the generator set to a variable load. Operate the generator set and vary the load as indicated in step c.

c. Record the master instrument readings and the readings of the meters at the following percentages of rated load: 25, 50, 75, 100, and 125.

d. The accuracy of the instruments should be such that the maximum error will not exceed the following parameters:

(1) Voltmeter: 2-1/2 percent of full scale except not greater than 5 volts between 115 and 125 volts, not greater than 10 volts between 200 and 250 volts.

(2) Ammeter: 2 percent of full scale.

(3) Kilowatt meter: 2 percent of full scale.

(4) Hertz (frequency) meter: 0.25 percent at any point on scale.

14-11. LOW OIL PRESSURE TRIP TEST. Perform this test as follows:

a. Install a test adapter with a gage for measuring pressure to the lubricating oil pressure switch, a valve for shutting off flow to pressure switch, and a valve for bleeding off pressure. Operate the generator set at rated speed and no load.

b. Purge air from system through the bleed valve. Close valve and record operating pressure.

CAUTION

If unit fails to shut down when oil pressure is below 15 +/-3 psi (103 +/-21 kPa), the test should be discontinued and corrective action taken.

c. Close pressure shutoff valve and slowly bleed pressure from system until the generator set shuts down and LOW OIL PRESSURE fault indicator lights. Record pressure. The generator set shutdown and LOW OIL PRESSURE fault locator indicator shall occur simultaneously at 15 +/-3 psi (103 +/-21 kPa).

d. Remove test components from generator set.

14-12. HIGH COOLANT TEMPERATURE TRIP TEST. Perform the high coolant temperature trip test as follows:

a. Remove coolant temperature transmitter from front of engine thermostat housing and install thermocouple in its place.

CAUTION

If the engine fails to shut down when 225°F (106°C) is reached, disconnect the load and unblock the radiator to cool engine.

b. Operate unit at rated speed, block air passing through the radiator and apply sufficient load to raise the unit temperature to the trip point of 222 +/-3°F (104.5 +/- 3°C). The high coolant temperature switch shall actuate at 219° to 225°F (102° to 106°C), causing the main circuit breaker to open, the engine to shut down, and the COOLANT HIGH TEMP fault indicator to light.

c. Remove thermocouple and replace coolant temperature transmitter.

14-13. LOW FUEL LEVEL TRIP TEST. Perform the low level trip test as follows:

a. Energize DC circuit breaker and position START-STOP-RUN switch to RUN to fill day tank. When day tank is full, the electric fuel transfer pumps will change pitch indicating they are bypassing fuel internally.

b. Disconnect electrical connector from day tank fuel solenoid valve.

c. Operate the generator set at rated voltage, frequency, and at full load until day tank float valve switch actuates, causing the main circuit breaker to open, the engine to shut down, and the NO FUEL fault indicator to light.

d. Start generator set and as soon as engine starts, lift red battle short switch guard and position switch to ON. Operate generator set for 1 minute at rated voltage, frequency and full load. Generator set should operate for 1 minute without running out of fuel. Shut down generator set, but do not de-energize DC circuit breaker.

e. Connect electrical connector to day tank fuel solenoid valve. Position START-STOP-RUN to RUN and fill day tank. Position BATTLE SHORT switch and guard to OFF position and de-energize DC circuit breaker.

14-14. OVER VOLTAGE TRIP TEST. Perform the over voltage trip tests as follows:

a. Connect a voltmeter between T9 and T12 of the monitored 120 volt phase.

b. Operate the generator set at no load, rated frequency, and rated voltage with main circuit breaker closed.

c. Over Voltage Trip Test. Raise voltage until the engine shuts down and OVER VOLT fault indicator lights. Record the voltage. The over voltage

relay shall actuate when the voltage exceeds 153 +/-3 volts for more then 200 milliseconds causing the main circuit breaker to open within 1 second, the engine to shut down, and the OVER VOLT fault indicator to light.

14-15. PHASE SEQUENCE CHECK. Perform the phase sequence check as follows:

a. Connect a suitable phase sequence indicator (a synchroscope or equivalent) to generator set load terminals.

b. Operate generator set and determine phase sequence by observing the indicator. The AC output connections shall be of the proper rotation; compare test results with the AC system schematic diagram (refer to the Operator and Organizational Maintenance Manual).

14-16. PHASE BALANCE TEST. Perform the phase balance test as follows:

a. Operate generator set at 240/416 volts, rated speed and no load. Adjust voltage as necessary until average voltage is 240 volts line-to-neutral. Measure each line-to-neutral voltage to the nearest 0.1 volt at load terminals and record.

NOTE

Load must be balanced. Record all three line-to-neutral voltages and obtain the average value. Reduce or raise voltage as required, by the amount that the previously computed average differs from average rated voltage. The average of the three phase voltages should be equal to rated voltage.

b. Measure and record each of the line-to-neutral voltages.

c. The maximum difference in the three line-to-neutral voltage under all balanced loads at rated voltage and speed shall not exceed 1 percent rated voltage and speed shall not exceed 1 percent rated line-to-neutral voltage. That is, no phase voltage shall differ from the average by more than 1.2 volts.

d. Formula to compute percentage of voltage unbalance is as follows:

$$\text{Voltage Unbalance (L-N), in percent} = \frac{V\ max - V\ min}{V\ rated} \times 100.$$

14-17. FREQUENCY ADJUSTMENT RANGE TEST. Perform the frequency adjustment range test as follows:

a. Operate generator set at rated speed by adjusting manual speed control. Record frequency.

b. Turn manual speed control knob 90 degrees. Record frequency. A 90-degree turn of the manual speed control knob shall not cause a change in frequency greater than 1 percent.

c. Repeat step b several times, both raising and lowering frequency.

d. Rapidly decrease engine speed by sliding the manual speed control knob out to obtain lowest possible speed. Increase engine speed by sliding the manual speed control knob in to obtain maximum possible speed obtainable. The manual speed control shall be adjustable from idle (approximately 1200 rpm) to 1800 +25 rpm.

14-18. REGULATOR RANGE TEST. Perform the regulator range test as follows:

a. Operate generator set at 240/416 volts and full load. Adjust voltage for 480 volts. Record voltage and speed. Adjust voltage for 395 volts. Record voltage and speed.

b. Reduce load to zero. Adjust voltage for maximum attainable voltage. Record voltage and speed. Adjust voltage for minimum voltage attainable. Record voltage and speed.

c. The generator set shall operate from no load to full load at the following line-to-line voltages:

(1) From 380 to 426 volts for 50 hertz operation.

(2) From 375 to 489 volts for 60 hertz operation.

14-19. EXCITER-REGULATOR AND GOVERNOR STABILITY AND TRANSIENT RESPONSE TEST. Perform the exciter-regulator and governor stability and transient response test as follows:

a. Operate generator set at 240/416 volts at full load until temperatures have stabilized.

b. Drop and apply the load a sufficient number of times to make sure that the voltage and frequency stay within prescribed tolerances.

c. The governor shall be set at 2.9 to 3 percent regulation. Adjust voltage to rated value. No further adjustments shall be made during this test. The recorders in the test circuit are now started.

d. Perform the following load switching sequence starting with full load and waiting approximately 30 seconds between each load change:

Adjust load to full load and starting from no load: full load - 0 - full load - 0 - full load - 0.

Adjust load to 3/4 load and starting from no load: 3/4 - 0 - 3/4 - 0 - 3/4 - 0.

Adjust load to 1/2 load and starting from no load: 1/2 - 0 - 1/2 - 0 - 1/2 - 0.

Adjust load to 1/4 load and starting from no load: 1/4 - 0 - 1/4 -0 - 1/4 - 0.

e. The frequency and voltage requirements are indicated below:

Frequency	Tolerance
Recovery Time	3 seconds
Overshoot and Undershoot	3 and 4 percent
Regulation	2 to 3 percent
Voltage	1 percent
Steady State Band	2 percent
Regulation	3 percent

14-20. LONG-TERM, STEADY-STATE STABILITY TEST. Perform the long-term, steady-state stability test as follows:

a. Operate the generator set at rated speed, voltage, and full load for a period of 4 hours.

b. Record voltage and frequency at start and finish of the 4 hour period. The long term steady deviation at constant loads from no load to full load shall be as follows:

(1) The bandwidth shall remain within 3 percent of the rated frequency.

(2) The bandwidth shall remain within 4 percent of the rated voltage.

14-21. ENGINE EFFICIENCY TEST. Perform the engine efficiency test as follows:

a. Operate the generator set at full rated load, speed, and voltage. Check the engine exhaust for excessive smoke and density of smoke.

b. The engine shall deliver 125 percent of rated load for 5 minutes. Engine exhaust smoke should be just visible at 100 percent load.

APPENDIX A

REFERENCES

A-1. FIRE PROTECTION.

TB 5-4200-200-10	Hand Portable Fire Extinguisher Approved for Army Users

A-2. LUBRICATION

C91001L	Fuels, Lubricants, Oils and Waxes
L05-6115-457-12	End Item Lubrication Order

A-3. PAINTING

T.O. 35-1-3	Painting and Marking of USAF Aerospace Ground Equipment
TM 9-213	Painting Instructions for Field Use

A-4. RADIO SUPPRESSION

MIL-STD-461	Radio Interference Suppression
TM 11-483	Radio Interference Suppression

A-5. MAINTENANCE.

T.O. 00-25-225	Repair of External Power Cables, Aerospace Ground Equipment
T.O. 00-25-234	General Shop Practice Requirements for the Repair, Maintenance and Test of Electronic Equipment
T.O. 1-1-1	Cleaning of Aerospace Equipment
T.O. 1-1A-14	Installation Practices for Aircraft Electric and Electronic Wiring
T.O. 1-1A-15	General Maintenance Instructions for Support Equipment
T.O. 31-1-75	General Maintenance Practices
T.O. 35-1-11	Organization, Intermediate and Depot Level Maintenance for FSC 6115 Non-Airborne-Equipment

T.O. 35-1-12	Compounds and Procedures for Cleaning Aerospace Ground Equipment
T.O. 35-1-26	Repair/Replacement Criteria for FSC 6115 Aerospace Ground Equipment
T.O. 35-1-524	USAF Equipment Registration Number System Applicable to FSC 6115 Equipment
TM 9-1870-1	Care and Maintenance of Pneumatic Tires
TB ORD 651	Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems
TM 38-750	The Army Maintenance Management System
TM 5-6115-457-12	Operator and Organizational Maintenance Manual
TM 5-6115-457-35	Intermediate (Field) (Direct and General Support) and Depot Maintenance Manual
TM 5-6115-457-25P	Organizational, Intermediate (Field) (Direct Support and General Support) and Depot Maintenance Repair Parts and Special Tools Lists
TM 9-6140-200-15	Operation and Organizational Field and Depot Maintenance Storage Batteries, Lead Acid Type
TM 5-764	Electric Motor and Generator Repair
MIL-HDBK-705	Military Standardization Handbook, Generator Sets, Electrical Measurements and Instruments
MIL-I-6868	Inspection Process, Magnetic Particle
MIL-I-25135	Inspection Materials, Penetrant
MIL-STD-120	Gage Inspection
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-705	Generator Sets, Engine-Driven Methods of Test and Instructions
MIL-STD-1261(MR)	Welding Procedures for Construction Steels
MIL-T-27730	Tape, Antiseize, Polytetrafluoroethylene, with Dispenser
MS 33540	Safety Wiring and Cotter Pinning, General Practices for

A-6. SHIPMENT AND STORAGE

T.O. 35-1-4	Processing and Inspection of Aerospace Ground Equipment for Storage and Shipment
T.O. 38-1-5	Processing and Inspection of Non-Mounted Non-Aircraft Gasoline and Diesel Engines for Storage and Shipment
TB 740-90-1	Administrative Storage of Equipment
TB 740-93-2	Preservation of USAMEC Mechanical Equipment for Shipment and Storage
TM 38-230	Preservation, Packaging and Packing of Military Supplies of Equipment
MIL-S-207	Sulfuric Acid, Electrolyte: Packaging, Packing, and Marking for Shipment and Storage of

A-7. DESTRUCTION OF MATERIEL

TM 750-244-3	Procedures for Destruction of Equipment to Prevent Enemy Use

INDEX

Subject	Paragraph, Figure, Table, Number

A - Continued

Subject	Paragraph, Figure, Table, Number

C - Continued

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Subject	Paragraph, Figure, Table, Number

E - Continued

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Subject	Paragraph, Figure, Table, Number

G - Continued

INDEX - Continued

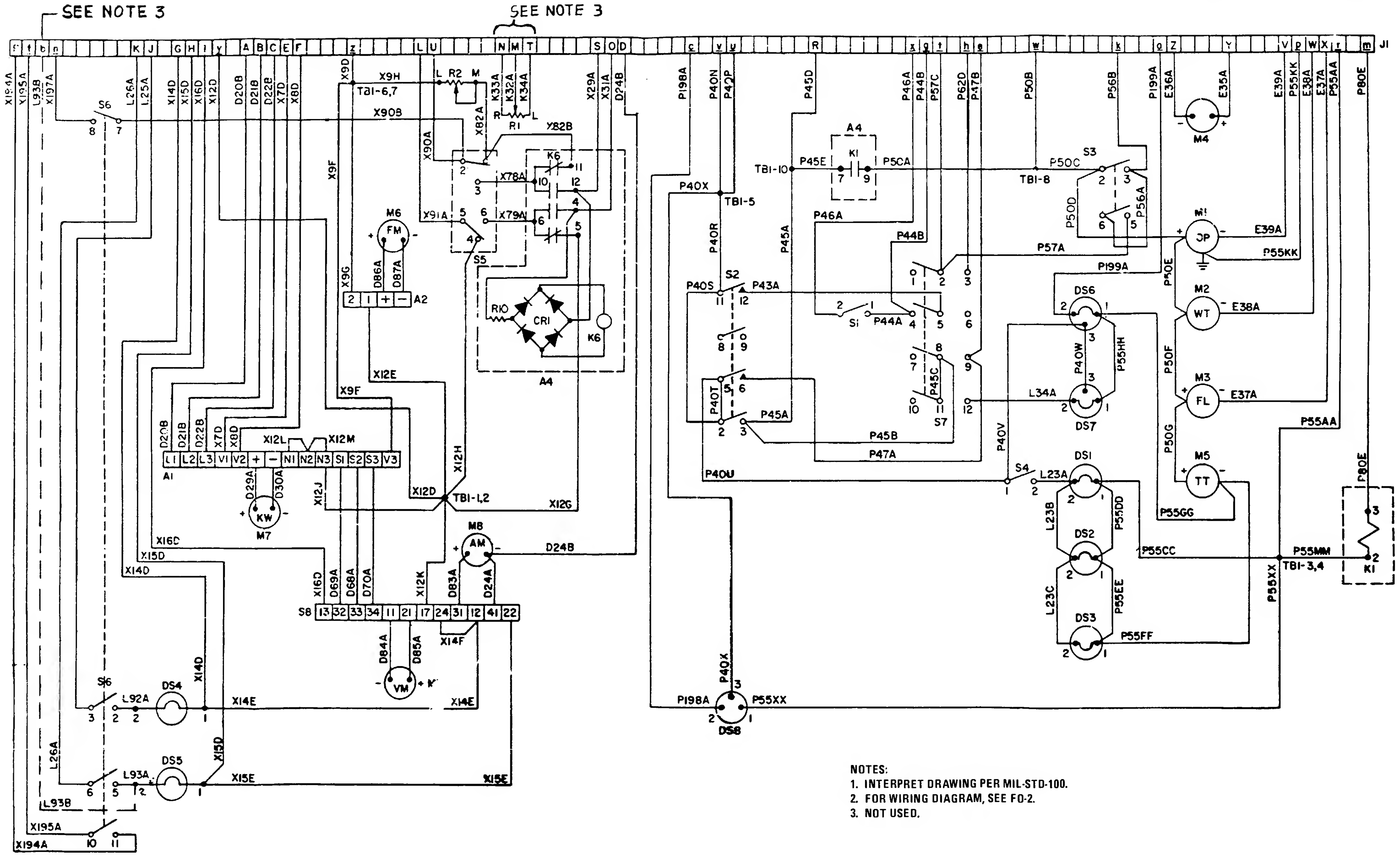
INDEX - Continued

Subject — Paragraph, Figure, Table, Number

S - Continued

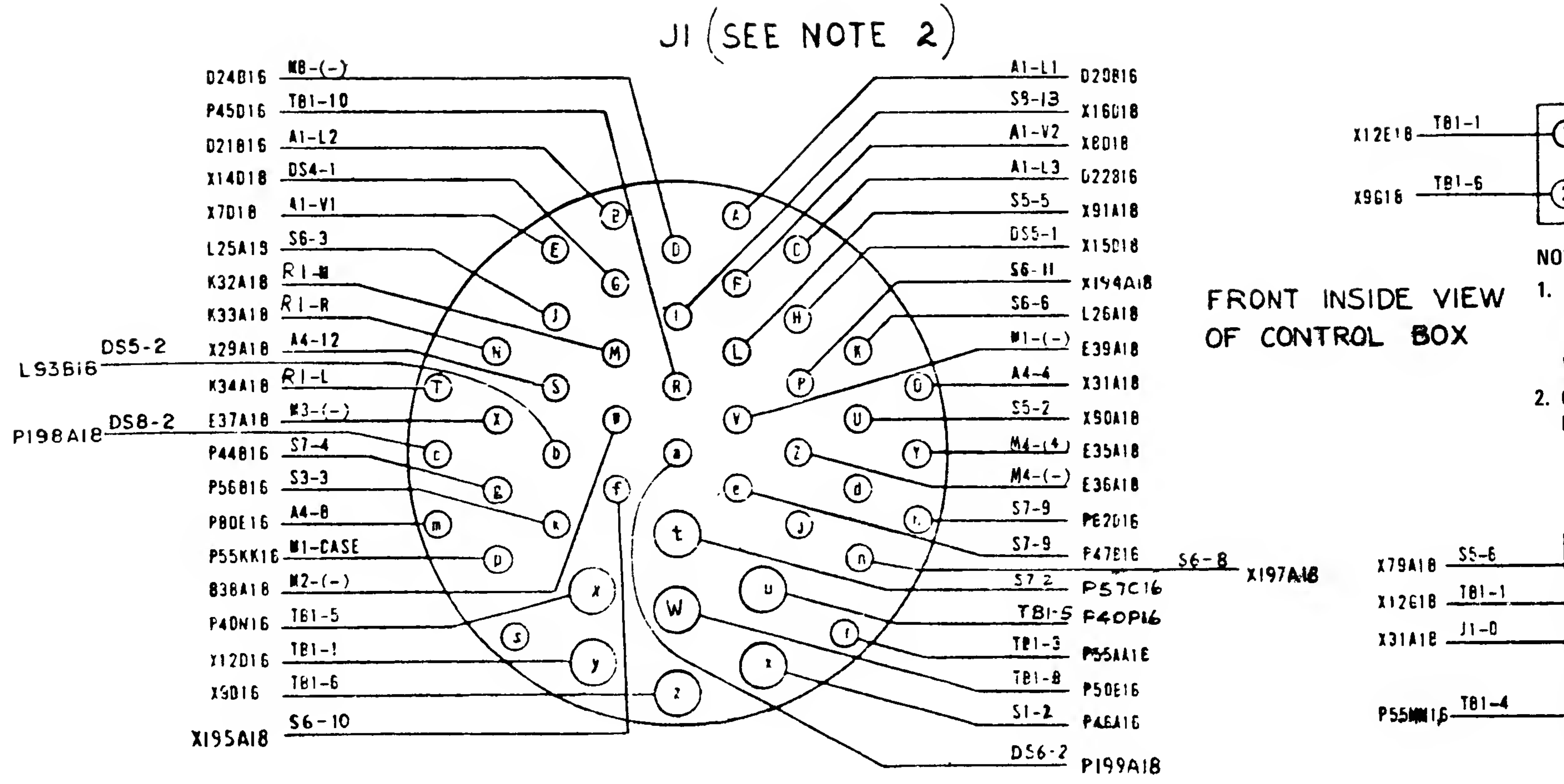
INDEX - Continued

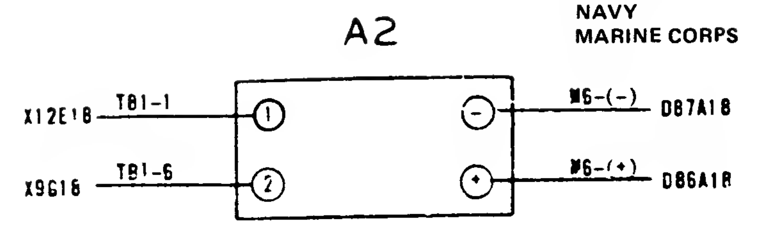
GPO 587-000 /1433



NOTES:
1. INTERPRET DRAWING PER MIL-STD-100.
2. FOR WIRING DIAGRAM, SEE FO-2.
3. NOT USED.

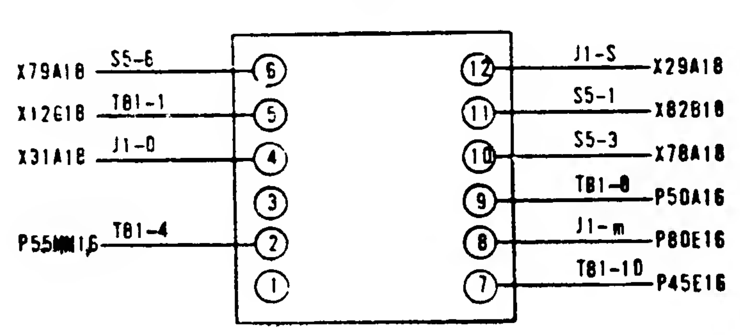
FO-1. Control Cubicle, Schematic Diagram

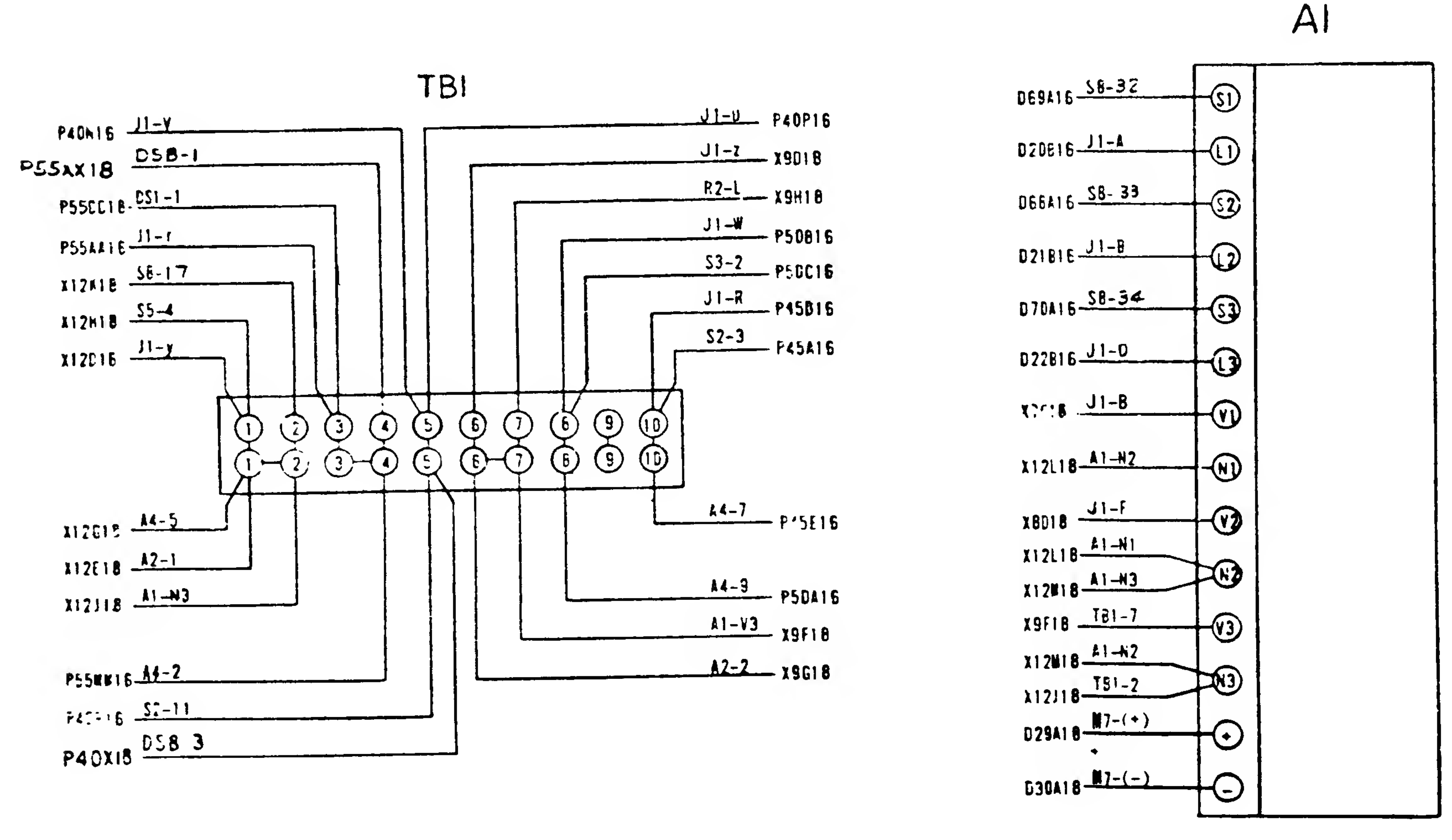




NOTES:

1. FOR INTERPRETATION OF ELECTRICAL REFERENCE DESIGNATIONS. SEE ASA Y32, 16 GRAPHIC SYMBOLS FOR ELECTRICAL DIAGRAM. SEE MIL-STD-15-1 WIRE IDENTIFICATION. SEE MIL-W-5088
2. OMIT R1 RHEOSTAT AND WIRE NO. K32A18, K33A18, K34A18 AND L93B18 FROM J1 CONNECTOR FOR 69-677-2 WIRING HARNESS.

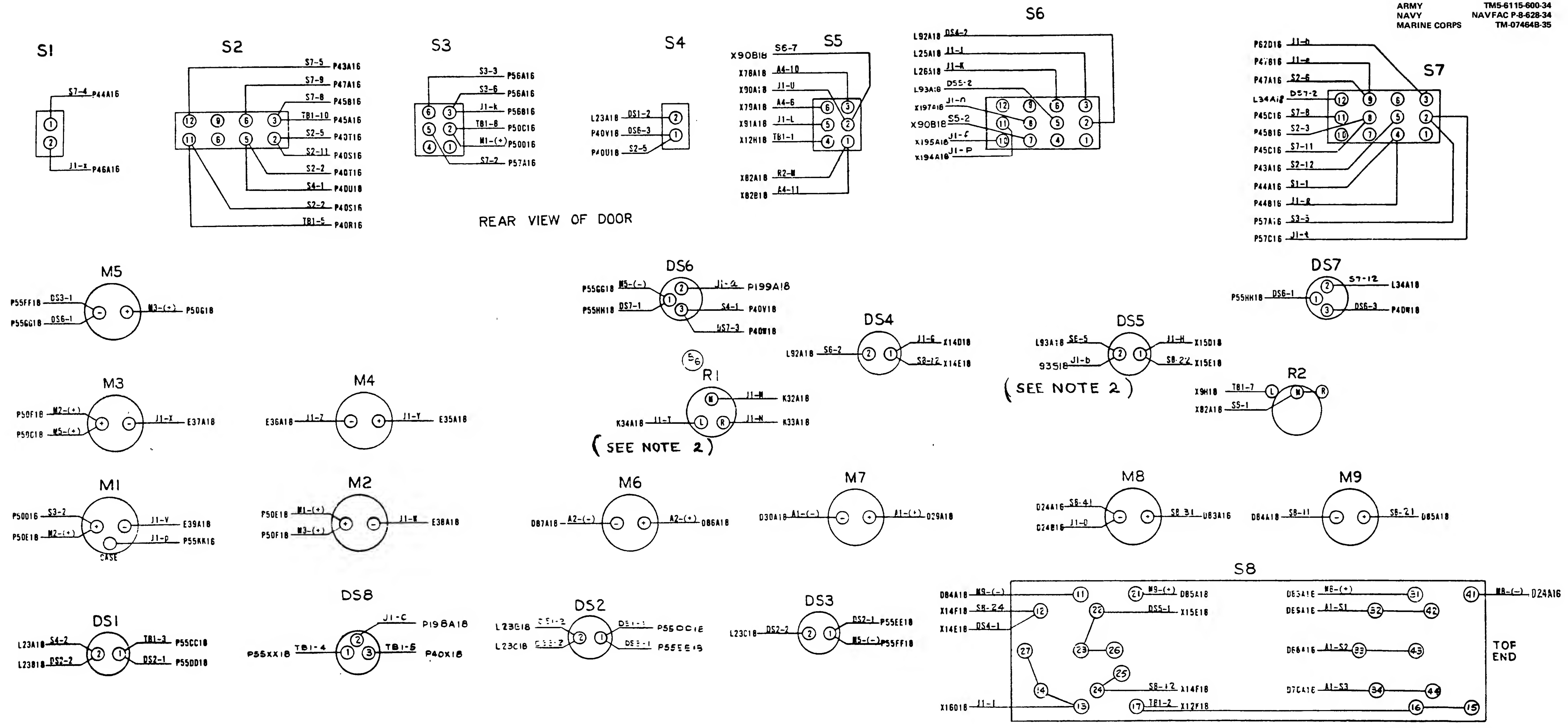




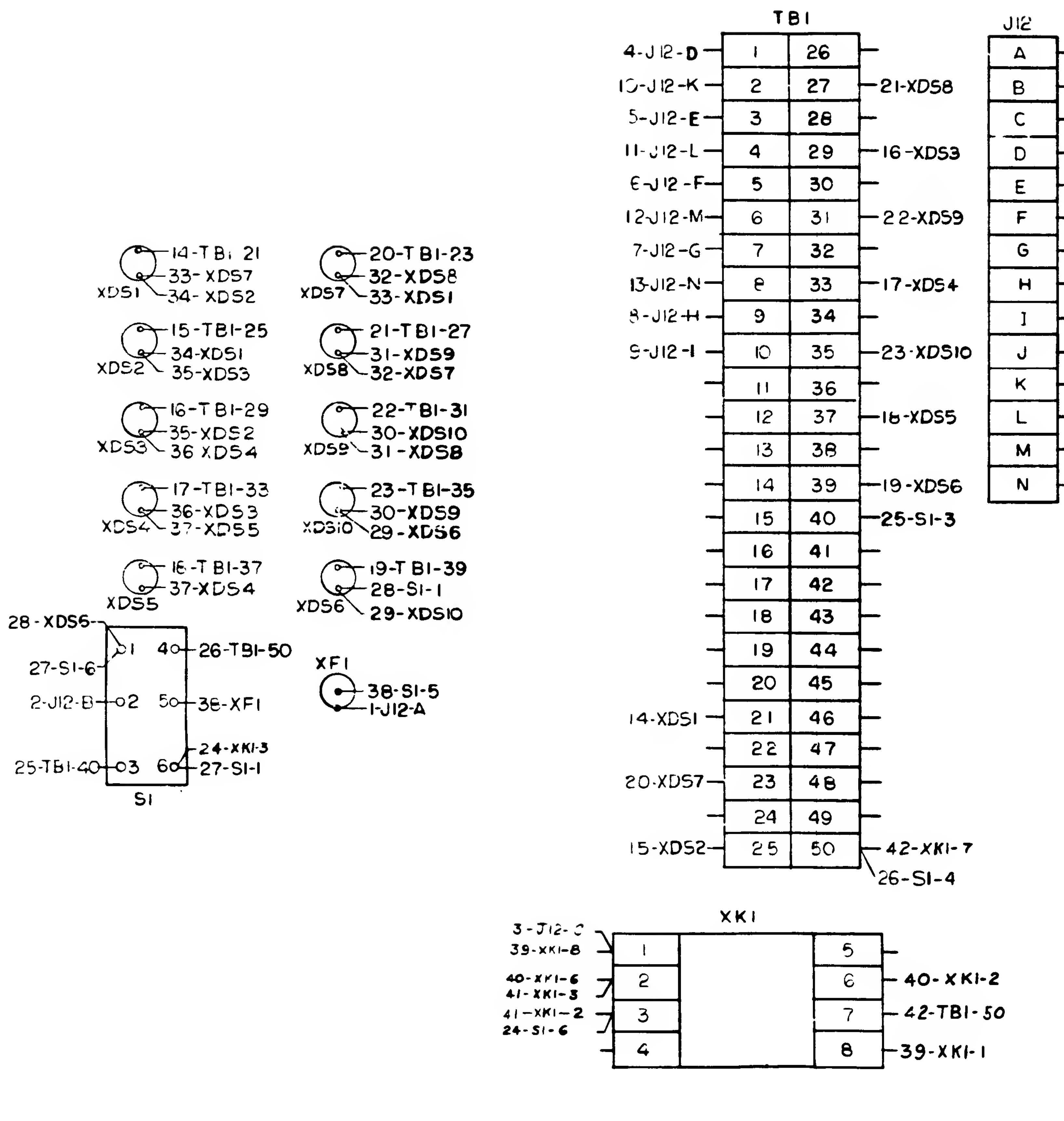
REFERENCE DESIGNATIONS

- A1 – CONVERTER, THERMAL WATT
- A2 – CONVERTER, FREQUENCY
- A4 – CONTROL PANEL RELAY ASSY
- DS1, DS2, DS3 – LIGHT, PANEL
- DS4, DS5 – LIGHT SYNCHRONIZING
- DS6 – LIGHT INDICATOR, CIRCUIT BREAKER
- DS7 – LIGHT, PROTECTION BYPASS
- J1 – CONNECTOR, RECEPTACLE
- M1 – METER, OIL PRESSURE
- M2 – METER, COOLANT TEMP
- M3 – METER, FUEL LEVEL
- M4 – METER, BATTERY CHARGER
- M5 – METER, TOTAL TIME
- M6 – METER, FREQUENCY
- M7 – METER, KILOWATT
- M8 – AMMETER, AC
- M9 – VOLTMETER
- R2 – RHEOSTAT, VOLTAGE ADJUSTING
- R1 – RHEOSTAT, FREQUENCY ADJUSTING (SEE NOTE 2)
- S1 – SWITCH, ENGINE PRIMER
- S2 – SWITCH, START–RUN–STOP
- S3 – SWITCH, CONTACTOR
- S4 – SWITCH, PANEL LIGHTS
- S5 – SWITCH, LOCAL–REMOTE VOLTAGE
- S6 – SWITCH, UNIT PARALLEL
- S7 – SWITCH, BATTLE SHORT
- S8 – SWITCH, AMMETER–VOLTMETER TRANSFER
- TB1 – TERMINAL BOARD

FO-2. Control Cubicle, Wiring Diagram (Sheet 1 of 2)

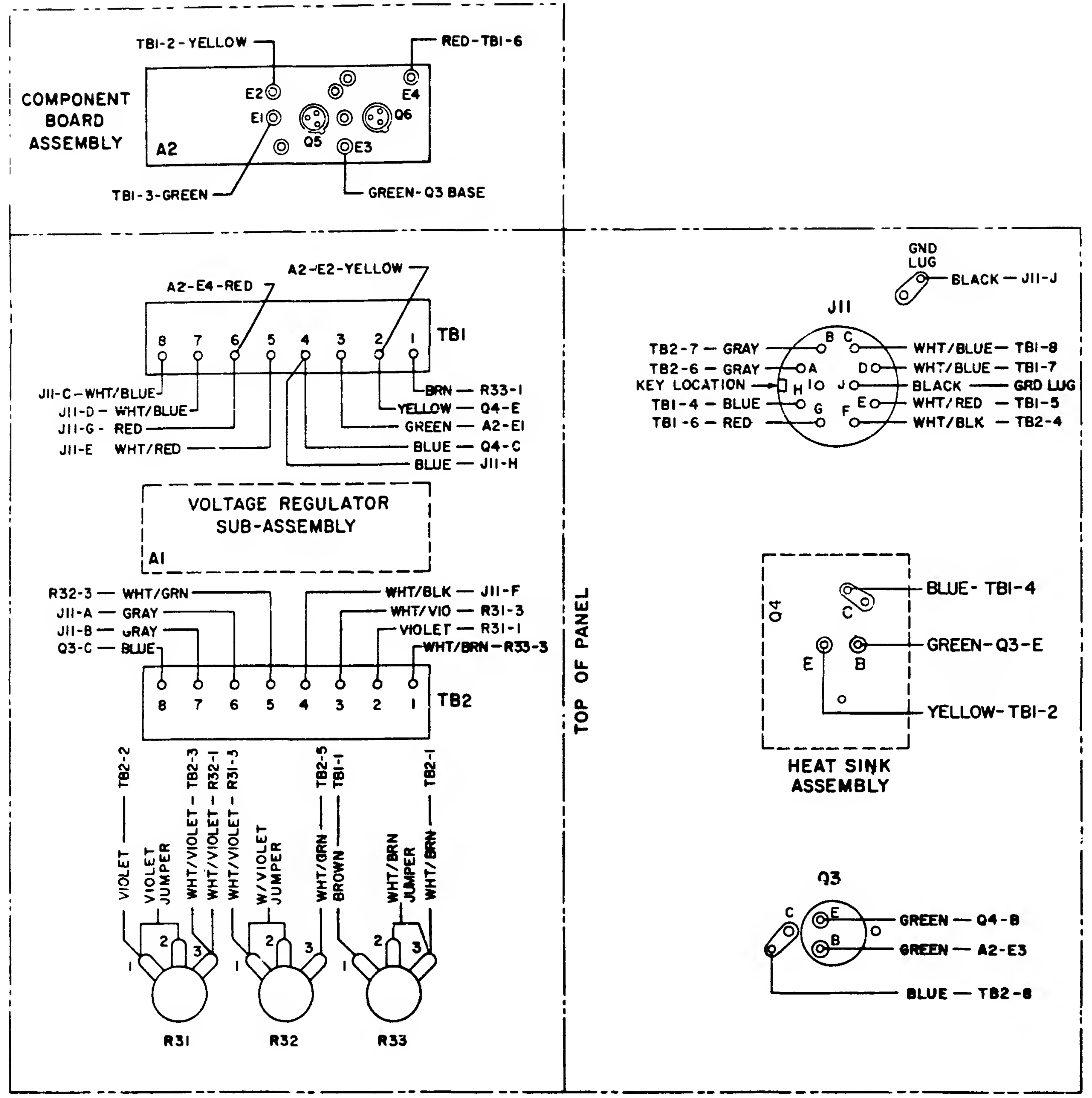


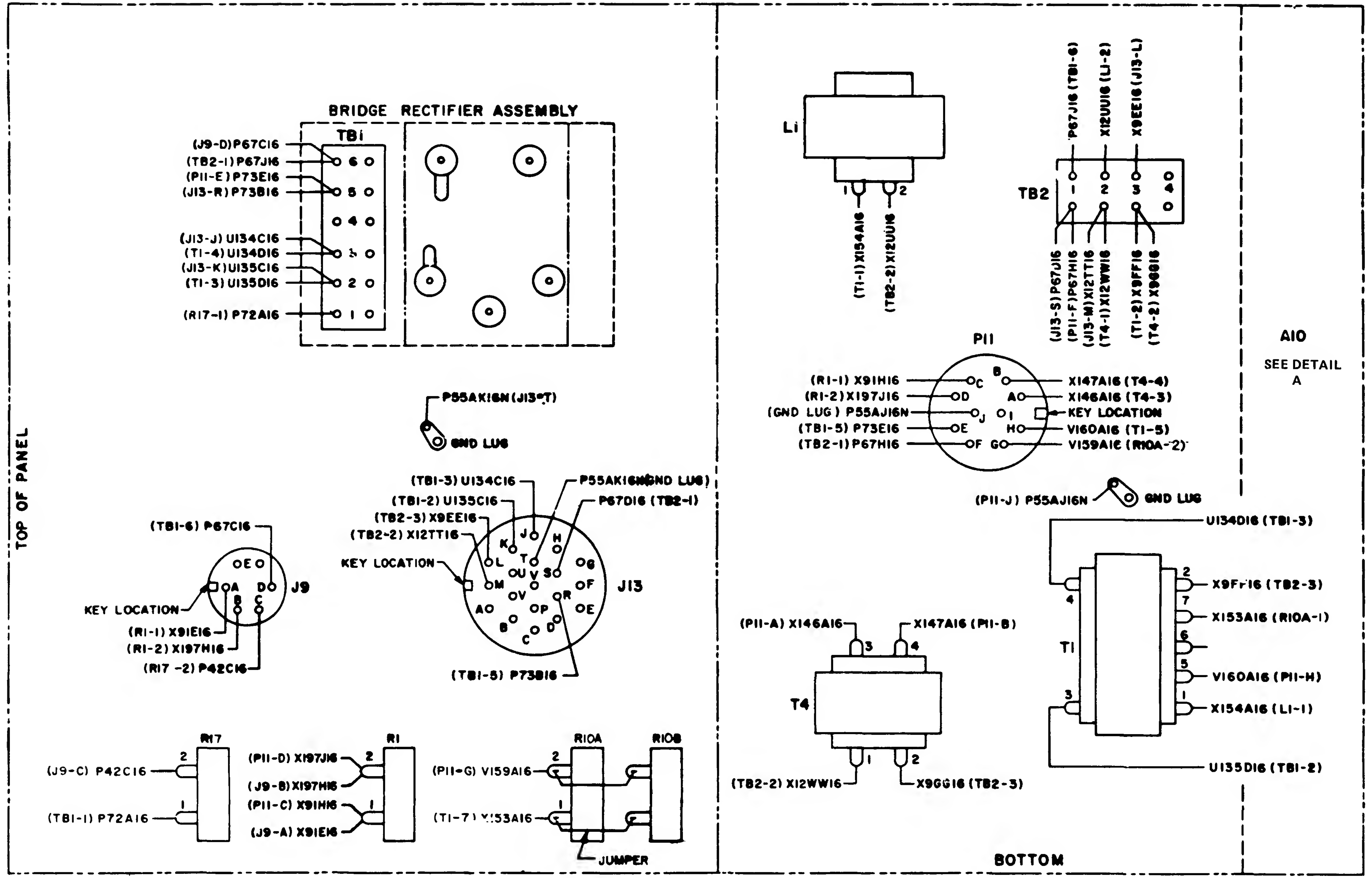
F0-2. Control Cubicle, Wiring Diagram
(Sheet 2 of 2)



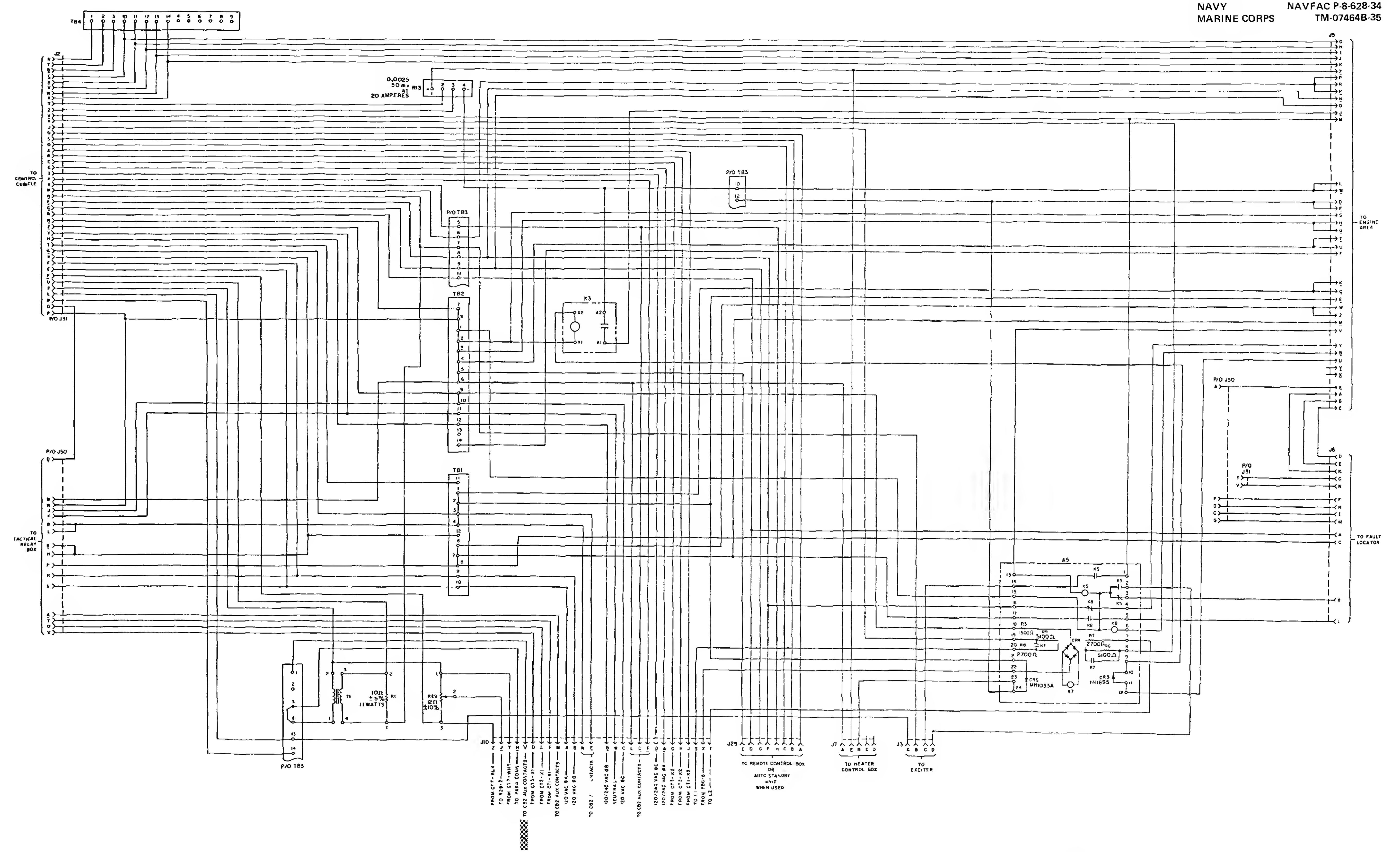
REFERENCE DESIGNATIONS
XF1-FUSEHOLDER
J12-CONNECTOR, RECEPTACLE
XK1-RELAY SOCKET
XDS1-LIGHT, INDICATOR, SOCKET
XDS2 " " "
XDS3 " " "
XDS4 " " "
XDS5 " " "
XDS6 " " "
XDS7 " " "
XDS8 " " "
XDS9 " " "
XDS10 " " "
S1-TOGGLE SWITCH
TB1-TERMINAL BOARD

FO-3. Fault Indicator Panel A9, Wiring Diagram


DETAIL A

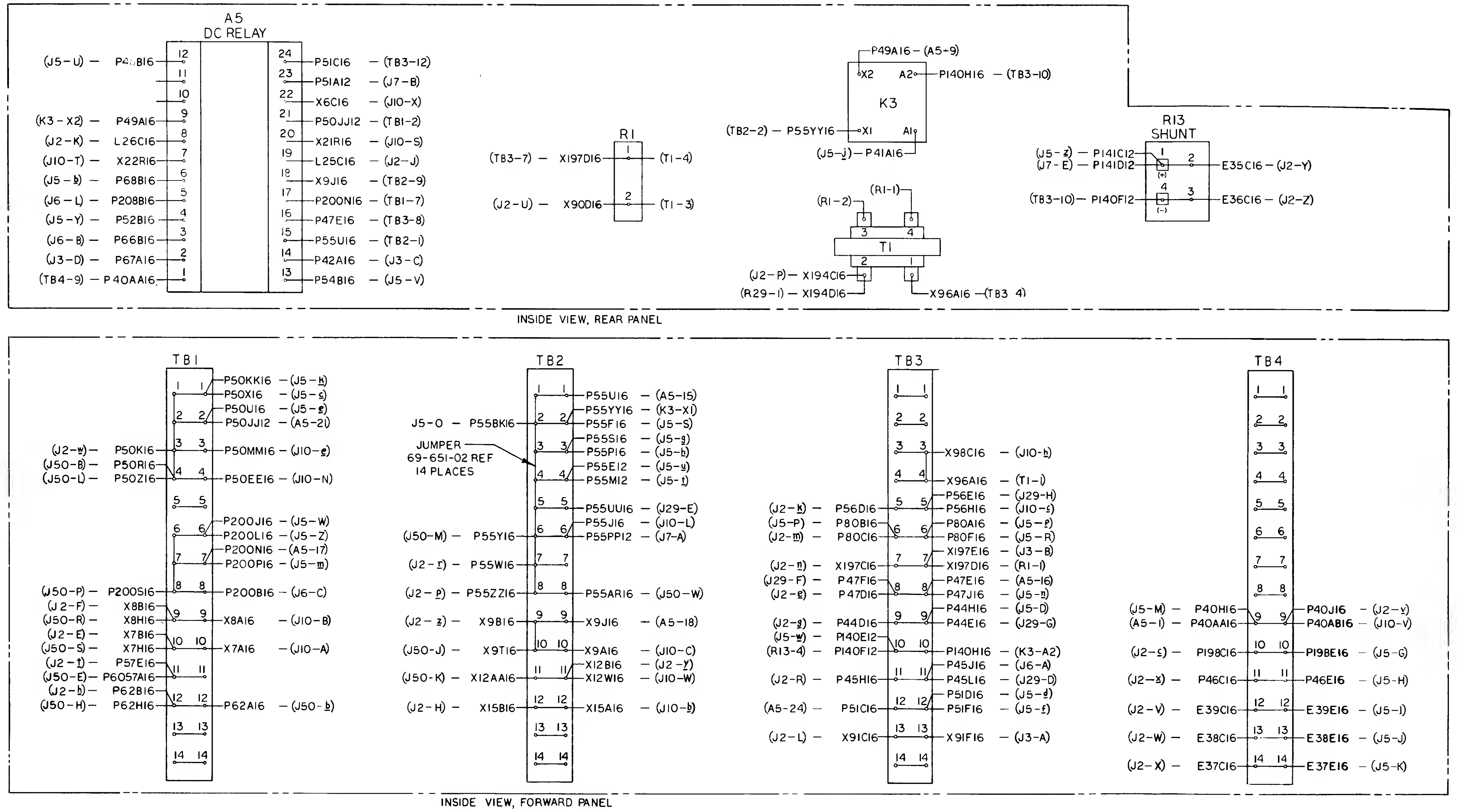


FO-4. Exciter-Regulator Wiring Diagram

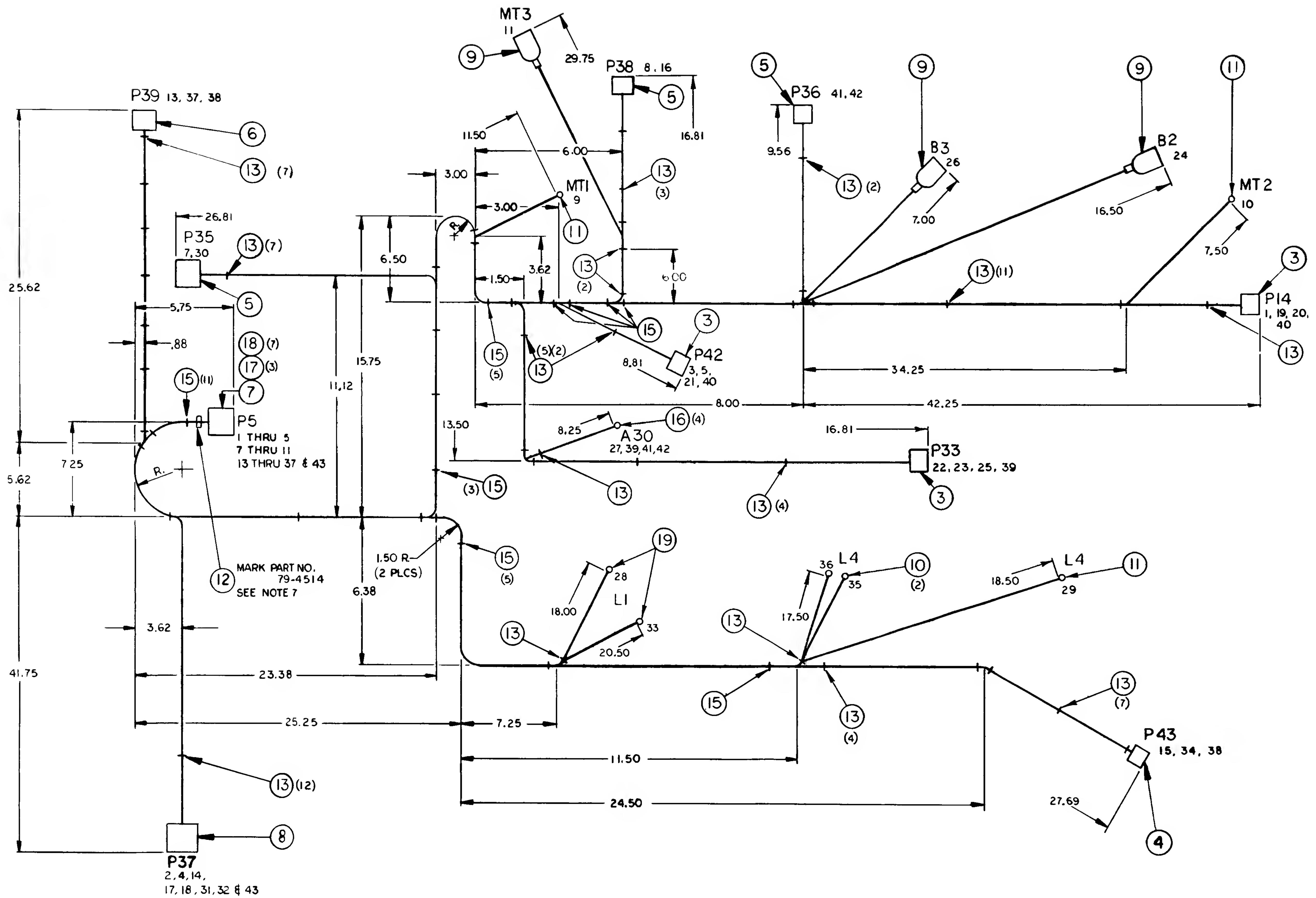


Change 2 FO-5. Mode I Relay Box A27, Schematic Diagram

FO-6. Mode I Relay Box A27, Wiring Diagram
(Sheet 1 of 2)



FO-6. Mode I Relay Box A27, Wiring Diagram
(Sheet 2 of 2)



WIRE NO:	WIRE MARKING IDENTIFICATION COLOR	NUMBER	FROM	TERMIN. FIND NO.	TO	TERMIN. FIND NO.	LG. REF.
1	RED	P207C16	P5-A	7	P14-B	3	105.0
2		P202C16	P5-B		P37-J	8	85.5
3		P201C16	P5-C		P42-D	3	67.5
4		P44 J16	P5-D		P37-A	8	53.0
5		P58 A16	P5-E		P42-C	3	67.5
6		P198D16	P5-G		P35-A	5	68.0
7		P46 D16	P5-H		P38-A	5	76.0
8		E39D16	P5-I		MT1	11	62.0
9		E38D16	P5-J		MT2	11	103.0
10		E37D16	P5-K		MT3	9	93.0
11		P40F16	P5-M		P39-A	6	29.0
12		P80H16	P5-P		P37-H	8	53.0
13		P80J16	P5-R		P43-A	4	89.0
14		P55H16	P5-S		P38-B	5	76.0
15		P48A16	P5-U		P37-B	8	53.0
16		P54A16	P5-V		P37-C	8	53.0
17		P200K16	P5-W		P14-C	3	104.0
18		P52A16	P5-Y		P14-D	3	103.0
19		P200M16	P5-Z		P42-A	3	67.5
20		P68A16	P5-b		P33-D	3	83.5
21		P50Y16	P5-c		P33-C	3	85.5
22		P51E16	P5-d		B2	9	70.0
23		P50W16	P5-e		P33-A	3	85.5
24		P51H16	P5-f		B3	9	68.0
25		P55T16	P5-g		A30-3	16	76.5
26		P55R16	P5-h		L1-1	19	62.0
27		P41B16	P5-j		L4-1	11	68.0
28		P50LL16	P5-k		P35-B	5	67.0
29		P200R16	P5-m		P37-F	8	53.0
30		P47K16	P5-n		P37-G	8	53.0
31		P80K16	P5-p		L1-2	19	64.5
32		P55N12	P5-t		P43-C	4	91.5
33		P55D12	P5-u		B1	10	66.0
34		P140D12	P5-w		L4-3	10	66.0
35		P141B12	P5-z	7	P39-C	6	29.0
36		P141A12	P43-B	4	P39-B	6	113.0
37		P69A16	P33-B	3	A30-1	16	24.0
38		P53A16	P42-B	3	P14-A	3	54.0
39		P55AX16	P36-B	5	A30-3	16	35.5
40		P69B16	P36-A	5	A30-2	16	35.5
41	RED	P55BJ16	P5-O	7	P37-1	8	53.0

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2

NOTES:

1. INTERPRET DRAWING PER MIL-STD-100.
2. ALL CONDUCTOR ENDS TO BE STRIPPED BACK APPROX. .25 INCH AND TINNED BEFORE ASSEMBLY.
3. USE SOLDER, FIND #14, SOLDER CONNECTIONS PER-MIL-STD-454 REQT 5.
4. CABLE STRAPS, FIND # 13 AND #15 SHALL BE SPACED APPROX. 3.00 INCH APART, UNLESS OTHERWISE SPECIFIED.
5. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W 5088. EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 INCH.
6. A. TRUNK BENDS TO BE 2.00 INCH RADIUS APPROX. EXCEPT WHERE OTHERWISE SPECIFIED.
   B. BREAKOUTS TO BE 1.00 INCH RADIUS APPROX.
7. PART NO. MARKING TO BE METAL STAMPED PER MIL-STD-130.

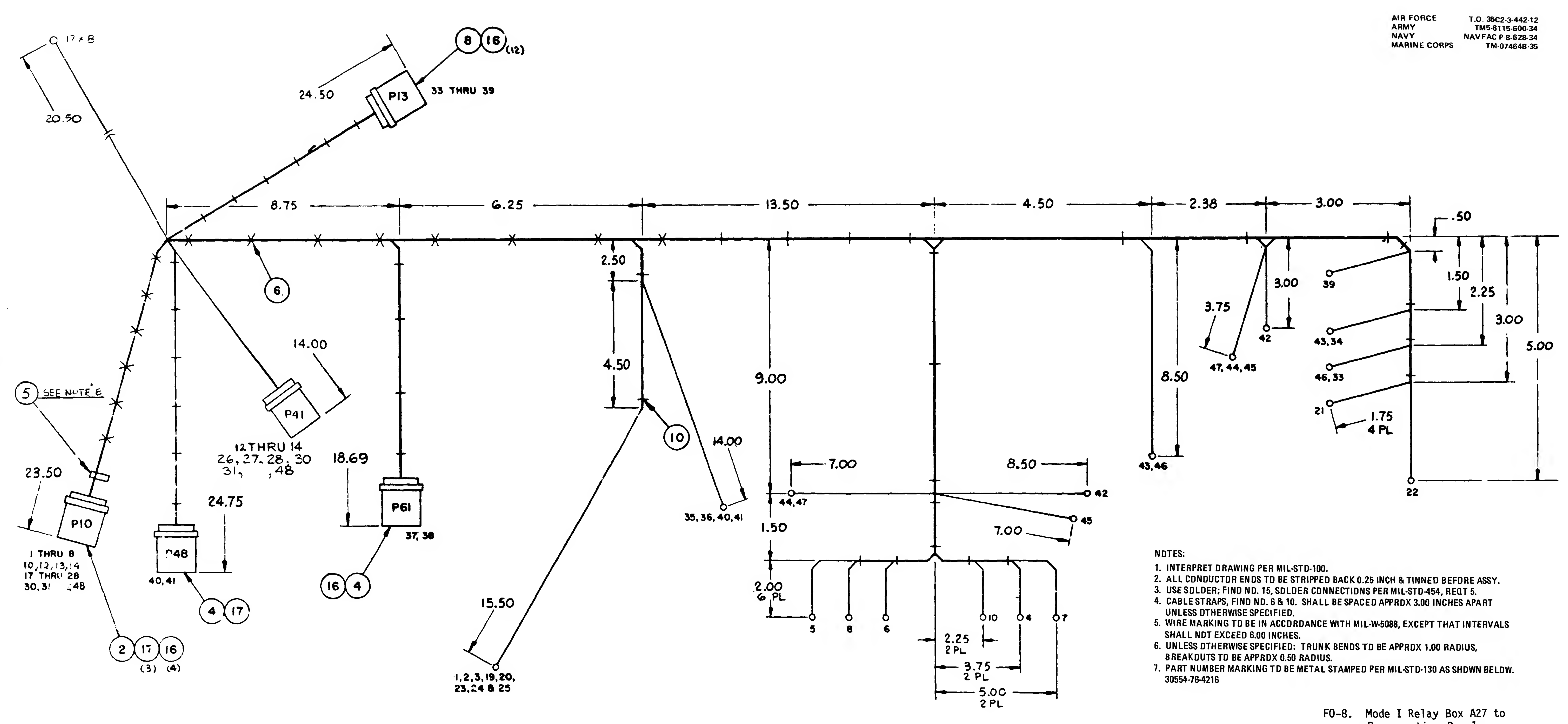
FIND NO	FSCM	DWG SIZE	PART OR IDENTIFYING NO.	QTY REQD	NOMENCLATURE OR DESCRIPTION	SPECIFICATION	MATERIAL
19			MS25036-153	2	TERMINAL LUG, CRIMP STYLE		
18			MS25251-16	12	PLUG, END SEAL		
17			MS25251-12	3	PLUG, END SEAL		
16			MS25036-106	4	TERMINAL LUG, CRIMP STYLE		
15			MS3367-1-9	29	STRAP, TIEDOWN		NYLON
14			SN60WRAP2	AR	SOLDER, LEAD, TIN ALLOY, ROSIN CORE	QQ-S-571	NOTE 3
13			MS3367-4-9	70	STRAP, TIEDOWN		NYLON
12			MS39020-4	1	BAND, MARKER		AL ALY
11			MS25036-108	3	TERMINAL LUG, CRIMP STYLE		
10			MS25036-158	2	TERMINAL LUG, CRIMP STYLE		
9			MS27144-2	3	CONNECTOR ASSEMBLY, MALE		
8			MS3106R18-1S	1	CONNECTOR, PLUG		
7			MS3106R36-7S	1	CONNECTOR, PLUG		
6			MS3106R16-10S	1	CONNECTOR, PLUG		
5			MS3106 R10SL-4S	3	CONNECTOR, PLUG		
4			MS3106R18-5P	1	CONNECTOR, PLUG		
3			MS3106R14S-2S	3	CONNECTOR, PLUG		
2			M5086/2-12-9	A/R	WIRE, ELECTRICAL	MIL-W-5086-2	
1			M5086/2-16-9	A/R	WIRE, ELECTRICAL	MIL-W-5086-2	

PARTS LIST

FO-7. Engine Accessories, Wiring Harness

WIRE NO	WIRE MARKING IDENTIFICATION COLOR	WIRE MARKING IDENTIFICATION NUMBER	FROM	TERMN FIND NO.	TO	TERMN FIND NO.	LG REF
1	BLACK	X7E16	P10-A	2	TB6-7	7	59.00
2	BLACK	X8E16	P10-B	2	TB6-8	7	59.00
3	BLACK	X9AA16	P10-C	2	TB6-9	7	59.00
4	BLACK	X19B16	P10-D	2	CT3-X1	13	68.00
5	BLACK	X18B16	P10-E	2	CT2-X1	13	68.00
6	BLACK	X17B16	P10-F	2	CT1-X1	13	66.50
7	BLACK	D22E16	P10-G	2	CT3-X2	13	68.00
8	BLACK	D21E16	P10-H	2	CT2-X2	13	68.00
9							
10	BLACK	D20E16	P10-J	2	CT1-X2	13	66.50
11							
12	RED	P55K16	P10-L	2	P41-B	3	34.50
13	RED	P63E16	P10-M	2	P41-A	3	34.50
14	RED	P50FF16	P10-N	2	P41-D	3	34.50
15							
16							
17	BLACK	X21S16	P10-S	2	CB2-A2	14	42.50
18	BLACK	X22S16	P10-T	2	CB2-B2	14	42.50
19	BLACK	X12X16	P10-W	2	TB6-12	7	59.00
20	BLACK	X6B16	P10-X	2	TB6-6	7	59.00
21	BLACK	X194F16	P10-Y	2	TB2-5	18	65.50
22	BLACK	X195E16	P10-Z	2	TB2-6	18	66.00
23	BLACK	X14A16	P10-a	2	TB6-1	7	59.00
24	BLACK	X15F16	P10-b	2	TB6-2	7	59.00
25	BLACK	X16A16	P10-d	2	TB6-3	7	59.00
26	RED	P56J16	P10-c	2	P41-C	3	34.50
27	RED	P50NN16	P10-e	2	P41-J	3	34.50
28	RED	P199D16	P10-f	2	P41-K	3	34.50
29							
30	BLACK	X97B16	P10-j	2	P41-E	3	34.50
31	BLACK	X98B16	P10-h	2	P41-F	3	34.50
32							
33	BLACK	U134B16	P13-J	8	TB2-4	18	66.50
34	BLACK	U135B16	P13-K	8	TB2-2	18	65.75
35	BLACK	X9DD16	P13-L	8	TB6-9	7	54.00
36	BLACK	X12SS16	P13-M	8	TB6-12	7	54.00
37	RED	P73C16	P13-R	8	P61-C	4	48.00
38	RED	P67E16	P13-S	8	P61-B	4	48.00
39	RED	P55AL16	P13-T	8	GND LUG	9	64.00
40	BLACK	X12MM12	P48-C	4	TB6-12	12	54.00
41	BLACK	X9MM12	P48-B	4	TB6-9	12	54.00
42	BLACK	U135A16	TB2-1	18	CT6-X2	13	26.50
43	BLACK	U135E16	TB2-2	18	CT4-X2	13	17.50
44	BLACK	U135F16	TB2-2	18	CT5-X2	13	24.75
45	BLACK	U134A16	TB2-3	18	CT6-X1	13	25.00
46	BLACK	U134E16	TB2-4	18	CT4-X1	13	17.00
47	BLACK	U134F16	TB2-4	18	CT5-X1	13	26.00
48	BLACK	P40AC16	P10-V	2	P41-M	3	34.50

WIRE LENGTH TOLERANCES		
OVER	INCL.	TOL. ±
0	.50	.12
.50	2	.19
2	6	.25
6	12	.38
12	36	.50
36	100	1
100	200	1.50
200	UP	2



NOTES:

1. INTERPRET DRAWING PER MIL-STD-100.
2. ALL CONDUCTOR ENDS TO BE STRIPPED BACK 0.25 INCH & TINNED BEFORE ASSY.
3. USE SOLDER; FIND NO. 15, SOLDER CONNECTIONS PER MIL-STD-454, REQT 5.
4. CABLE STRAPS, FIND NO. 6 & 10. SHALL BE SPACED APPROX 3.00 INCHES APART UNLESS OTHERWISE SPECIFIED.
5. WIRE MARKING TO BE IN ACCORDANCE WITH MIL-W-5088, EXCEPT THAT INTERVALS SHALL NOT EXCEED 6.00 INCHES.
6. UNLESS OTHERWISE SPECIFIED: TRUNK BENDS TO BE APPROX 1.00 RADIUS, BREAKOUTS TO BE APPROX 0.50 RADIUS.
7. PART NUMBER MARKING TO BE METAL STAMPED PER MIL-STD-130 AS SHOWN BELOW.
30554-76-4216

FO-8. Mode I Relay Box A27 to Reconnection Panel, Wiring Harness